REPORT RESUMES

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A COST-EFFECTIVENESS MODEL FOR THE ANALYSIS OF TITLE I ESEA PROJECT PROPOSALS, PART I-VII.

BY- ABT, CLARK C.

ABT ASSOCIATES INC., CAMBRIDGE, MASS.

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SEVEN SEPARATE REPORTS DESCRIBE AN OVERVIEW OF A COST-EFFECTIVENESS MODEL AND FIVE SUBMODELS FOR EVALUATING THE EFFECTIVENESS OF ELEMENTARY AND SECONDARY ACT TITLE I PROPOSALS. THE DESIGN FOR THE MODEL ATTEMPTS A QUANTITATIVE DESCRIPTION OF EDUCATION SYSTEMS WHICH MAY BE PROGRAMED AS A COMPUTER SIMULATION TO INDICATE THE IMPACT OF A TITLE I PROJECT ON THE SCHOOL, THE STUDENTS, AND THE COMMUNITY. THE OVERALL COST-EFFECTIVENESS MODEL FOCUSES ON CHANGES IN STUDENT ACHIEVEMENT, ATTITUDINAL AND ENVIRONMENTAL FACTORS INFLUENCING ACHIEVEMENT, AND SOCIAL BEHAVIORS AND COMMUNITY IMPACTS OF IMPROVED ACHIEVEMENT IN THE DISADVANTAGED. THE FIVE SUBMODELS COMPRISING THE OVERALL MODEL ARE--(1) SCHOOL, AND (2) INSTRUCTIONAL PROCESS, (3) COMMUNITY INTERACTIONS, (4) COSTS, AND (5) COST-EFFECTIVENESS. THE SCHOOL SUBMODEL REPRESENTS THE PROCESS IN WHICH FOUR STUDENT TYPES (WHITE AND NONWHITE WITH FAMILY INCOMES ABOVE AND BELOW $2,000) AND EDUCATION RESOURCES (TEACHERS, EQUIPMENT, ETC.) ARE CONVERTED INTO BETTER-EDUCATED INDIVIDUALS. THE INSTRUCTIONAL PROCESS SUBMODEL INDICATES THE STUDENT ACHIEVEMENT AND ATTITUDE CHANGES RESULTING FROM TITLE I PROGRAMS. THE COMMUNITY INTERACTIONS SUBMODEL ESTIMATES THE IMPACT ON SEVEN COMMUNITY VARIABLES OF CHANGES IN THE EDUCATIONAL SYSTEM DUE TO TITLE I PROGRAMS. THE COST SUBMODEL ACCOUNTS FOR BOTH THE DIRECT AND INDIRECT COSTS OF TITLE I PROGRAMS. THE EFFECTIVENESS SUBMODEL ANALYZES THE OUTPUT OF THE RESULTS OF THE OTHER SUBMODELS. ONE OF THESE SEVEN REPORTS DESCRIBES THE OFFICE OF EDUCATION COST-EFFECTIVENESS SIMULATION. (JL)

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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NATIONAL CENTER FOR EDUCATIONAL STATISTICS
Division of Operations Analysis

A COST-EFFECTIVENESS MODEL FOR THE ANALYSIS OF TITLE I ESEA PROJECT PROPOSALS

PART I

AN OVERVIEW OF THE COST-EFFECTIVENESS MODEL AND SUBMODELS FOR THE EVALUATION OF TITLE I ESEA PROPOSALS

Prepared for the Division of Operations Analysis

by

Abt Associates, Inc.
Under Contract No. OEC 1-6-001681-1681

Technical Note
Number 14
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NATIONAL CENTER FOR EDUCATIONAL STATISTICS
Alexander M. Mood, Assistant Commissioner

DIVISION OF OPERATIONS ANALYSIS
David S. Stoller, Director

PREFACE

This Technical Note is the first of a seven-part issue which describes a Cost-Effectiveness Model for the analysis of Title I ESEA Project Proposals. The seven parts are:

TN-14	Part I -	An Overview of the Cost-Effectiveness Model and Submodels for the Evaluation of Title I ESEA Proposals
TN-15	Part II -	The School Submodel
TN-16	Part III -	The Instructional Process Submodel
TN-17	Part IV -	The Community Submodel
TN-18	Part V -	The Cost Submodel
TN-19	Part VI -	The Effectiveness Submodel
TN-20	Part VII -	The Simulation

The model was developed by Abt Associates, of Cambridge, Massachusetts, for the Division of Operations Analysis, National Center for Educational Statistics, under contract number OEC 1-6-001681-1681.

DESIGN FOR AN EDUCATION SYSTEM COST-EFFECTIVENESS MODEL

by

Dr. Clark C. Abt
Abt Associates Inc.
Cambridge, Massachusetts

This presents a design for an elementary and secondary education cost-effectiveness model, emphasizing evaluation of the U.S. Elementary and Secondary Education Act's Title I programs for the disadvantaged. Substantively, the design reflects a concern for the exploitation of all available data on results accomplished by educational systems, as well as what is known about learning and influence processes. Methodologically, the design attempts a quantitative description of education systems, that may be programmed as a computer simulation that will produce quantitative indications of the impact of a Title I project on the school, the students and the community.

The model at this writing has been partly programmed for computer simulation, and empirical data are being collected for the validation.

The model was developed in 1966 under contract for the U.S. Office of Education's Division of Operations Analysis, by an interdisciplinary team at Abt Associates Inc., a private research firm located in Cambridge, Massachusetts. Some five man-years of professional effort were expended by fifteen professionals under the direction of the writer. The writer gratefully acknowledges the inspiration and encouragement given by Dr. Alexander Mood, Assistant Commissioner for Educational Statistics; the wise direction and warm support of Dr. David Stoller, Director of the Division of Operations Analysis; Dr. Richard Powers, Chief of the Education Economics Analysis Branch; and Mr. Martin Spickler; all of the U.S. Office of Education. Significant parts of the model design are the work of my colleagues at Abt Associates Inc., Stephen Bornstein, Louis Cutrona, Stephen Fitzsimmons (deputy project director), Raymond Glazier, James Hodder, Holly Kinley, Peter Miller (deputy project director), M. Keith Moore, Martha Mulloy, Michael Pritchett, Robert Rea, Martha Rosen, and Richard Rosen. Professor Andre Daniere and Mr. George Thomas of Harvard University generously gave advice and information.

THE OVERALL MODEL AND THE SUBMODELS

The purpose of the overall education cost-effectiveness model is to evaluate the relative school, student, and community effects and associated costs of alternative ESEA Title I programs for the disadvantaged.

Since such programs are directed toward increasing learning, the model focuses strongly on the changes in student achievement, the attitudes and environmental factors influencing achievement, and the social behaviors and community impacts of improved achievement in the target population.

The model may be described as a micro-educational model, because of its representation of some of the detail components of the education process. However, the model does not pretend to be a microanalysis of learning and influence processes, although these processes are represented by whatever objective correlatives are available in the form of qualitative numerical indices.

The model also does not pretend to be an exhaustive representation of what leads to changed student achievement, attitudes, earning potential, and equality of educational opportunity. The attempt was to emphasize those aspects of the education process that seem most relevant to achievement increases in students affected by Title I programs, and for which quantitative data is widely available.

Some attitudinal variables believed decisive for the learning process are not yet quantitatively defined, and there is only qualitative, impressionistic data available on them. Rather than simply omit such troublesome but significant variables, and thus falsely imply insignificance by omission, the qualitative variables are sometimes given numerical index ratings roughly corresponding to such qualitative distinctions as are offered by empirical but impressionistic data. In other cases, qualitative variables are built up numerically from components for which better data is available, or assigned index values by user judgment. In all cases, the attempt has been made to achieve a useful balance among the demands of data input, model complexity and validity of output.

The model's emphasis is on what the education system produces in terms of quantities and qualities, rather than how it does so. However, a certain amount of detail on how it produces its effects was essential to simulate for forecasting what it will do.

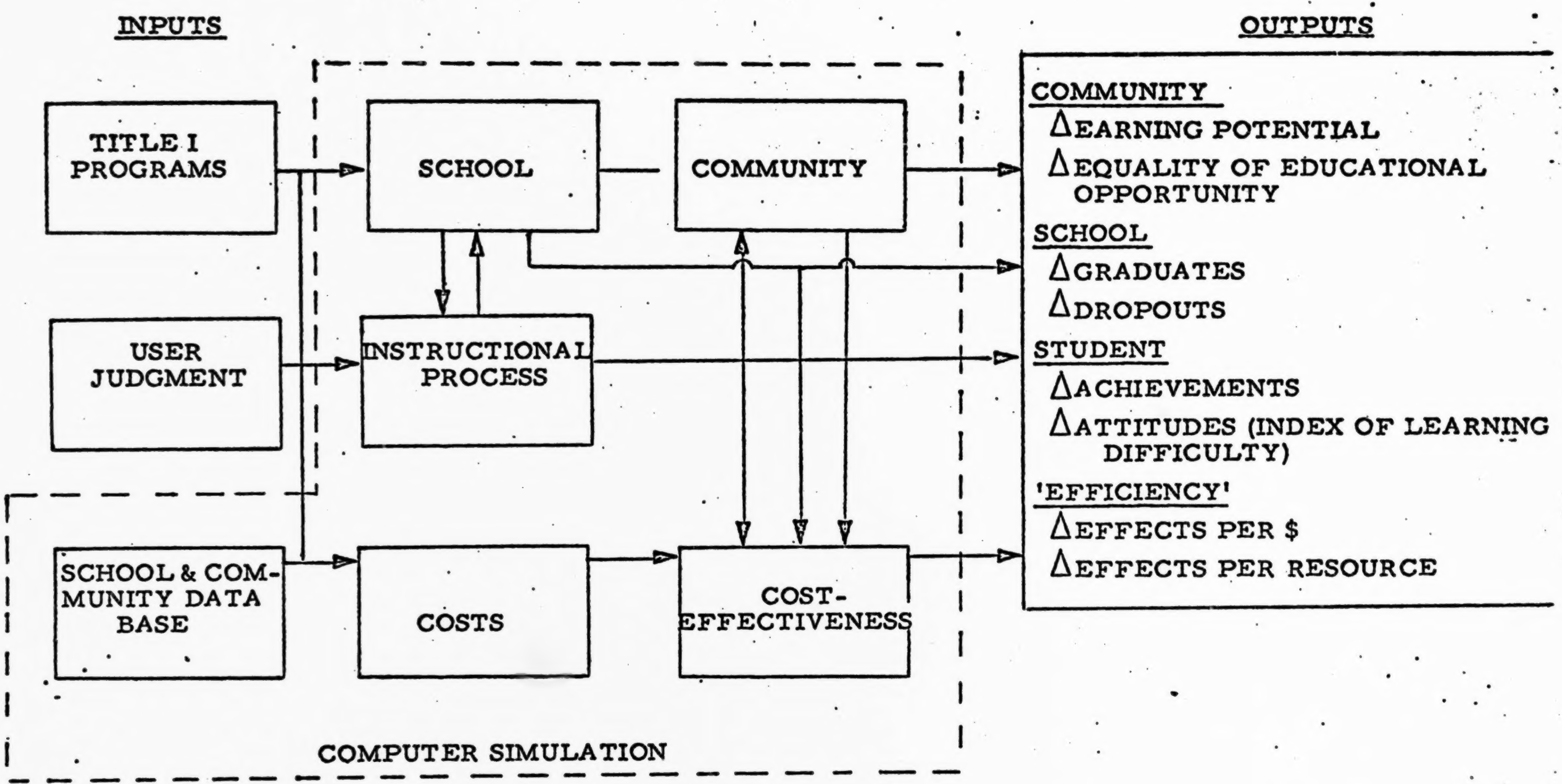
The model is not initially expected to be predictive, but only indicative of the relative cost-effectiveness of alternative Title I programs. Prediction requires regularity of process, and no two schools, student populations, or communities are alike. Even the calibration of the model with previous Title I before-and-after data will only improve its indication of the probable relative effectiveness of programs, because of the uniqueness of each case. Only to the extent that Title I situations are similar and are accurately measured and modeled, can their impact be forecast. However, even such a limited cost-effectiveness forecasting and evaluation model as that described here offers a substantial aid to education planners and policy-makers.

The overall model consists of five submodels: (See Figure I below)

--School
--Instructional Process
--Community Interactions
--Costs
--Cost-Effectiveness

The School Submodel represents the production process whereby the inputs of four partially educated students types (white and non-white, above and below $2,000 family income) and education resources (teachers, equipment, facilities, community environment) are transformed into better educated individuals, graduates, and dropouts. Inputs include Title I programs, previous school achievement and student sociological data, and specific improved achievement in the target population. Outputs are the change in numbers of graduates, dropouts, achievement levels by grade and student type, and critical achievement areas.

The Instructional Process Submodel represents the specific improvements in student achievement and attitude resulting from a Title I program. It attempts to reproduce the effects of the influence process whereby behavior and attitude are modified by exposures to teacher,



INPUTS
OUTPUTS
TITLE I PROGRAMS
USER JUDGMENT
SCHOOL & COMMUNITY DATA BASE
SCHOOL
COMMUNITY
INSTRUCTIONAL PROCESS
COSTS
COST-EFFECTIVENESS
COMPUTER SIMULATION
COMMUNITY
ΔEARNING POTENTIAL
ΔEQUALITY OF EDUCATIONAL OPPORTUNITY
SCHOOL
ΔGRADUATES
ΔDROPOUTS
STUDENT
ΔACHIEVEMENTS
ΔATTITUDES (INDEX OF LEARNING DIFFICULTY)
'EFFICIENCY'
ΔEFFECTS PER $
ΔEFFECTS PER RESOURCE

Figure 1: Cost-Effectiveness Model Overview Showing Inputs, 5 Submodels, and Outputs.

parent, and peer of varying duration and intensity. Inputs are the Title I program, previous and current changes in attitudes and achievements, and sociological data. Outputs are changes in achievement and attitude ('Index of Learning Difficulty') by student type.

The Community Interactions Submodel estimates the impact on seven community variables of the changes in education system output due to Title I programs. The inputs are the School Submodel outputs of changes in numbers of graduates, dropouts, and achievement levels; the Instructional Process outputs of changed student achievement and attitude; and community characteristics from the Data Base. Outputs are the community changes in terms of changes in lifetime earning potential and equality of educational opportunity.

The Cost Submodel accounts for all direct and indirect costs required to implement Title I programs. It allows the user to associate specific costs with specific components of the program and their effects. Inputs are the Title I program description and costs, and the real national average costs of typical Title I items. The submodel compares typical and proposed costs to allow the user to evaluate the efficiency of the proposed expenditures. Outputs are the total costs of the program, the added resources bought, and total program costs broken down by component parts.

The Effectiveness Submodel is the submodel in which the analysis and the output of the results determined by the other submodels takes place. The inputs to the Effectiveness Submodel are all of the variables which are in the Data Base at any time, the outputs of all of the above submodels (i.e., student, school, and community effects), and their associated costs. Outputs are efficiency data, measures of education effectiveness, and descriptive school, student and community data. Specific efficiency measures are effects per cost, values per cost, effects per resource, and values per resource.

The outputs of each Title I program would be evaluated by at least one model 'run,' and comparison of alternate programs can be made by comparing respective effects and costs. Both different programs for the same target population, and the same or different programs for different target populations may thus be compared. The tables below are examples of typical computer printouts (output) of a model run for a single specific school improvement project, giving before-project and after-project achievement, attitude and economic data on students by population type.

```
                       SUMMARY OUTPUT

             U.S.O.E. COST-EFFECTIVENESS MODEL

     COMMUNITY:  FERNDALE              PROJECT  REMEDIAL
                 MASS                  TYPE:    READING

     TARGET      G2-3                  ANNUAL
     POPULATION: SCHOOL B              COST:    85000

     POP   AVERAGE      INDEX  NO.    NO.   1000S CORR
     TYPE ACHIEVEMENT LEARN  DROP-  GRADS LIFE  SES &
          TGT-G  G-12 DIFFI  OUTS   G-12  EARNS ACHMT

BEFORE    1   1.2    8.6    86     20     28    140   0.86
PROJ      2   2.0   10.3    84     16     31    190   0.70
YEAR:     3   1.4    7.9    80     21     27    175   0.60
1965      4   3.2   12.7    56      9     46    270   0.30

AFTER     1   1.8   10.2    86     16     32    195   0.65
PROJ      2   2.6   11.0    84     12     35    220   0.60
YEAR:     3   2.4   11.2    80     17     31    215   0.50
1967      4   3.2   12.7    56      8     47    280   0.30


           POPULATION TYPES
       1 NON-WHITES UNDER 2000 INCOME
       2 NON-WHITES OVER  2000 INCOME
       3 WHITES     UNDER 2000 INCOME
       4 WHITES     OVER  2000 INCOME
```

ACHIEVEMENT OUTPUTS
BY GRADE, SUBJECTS, AND POPULATION TYPES

COMMUNITY:	FERNDALE MASS	PROJECT TYPE:	REMEDIAL READING
TARGET POPULATION:	G2-3 SCHOOL B	ANNUAL COST:	85000

GRADE LEVELS IN LANGUAGE

	POP TYPE	GRADE 1	2	3	4	5	6	7	8	9	10	11	12
BEFORE	1	.6	1.1	1.6	2.3	3.0	3.8	4.5	5.2	7.0	7.6	8.2	8.9
PROJCT	2	.8	1.2	1.9	2.9	3.4	4.5	5.1	6.0	7.7	8.4	9.3	10.0
YEAR:	3	.8	1.3	2.0	3.1	3.7	4.9	5.8	6.6	8.6	9.2	9.9	10.9
1965	4	1.2	2.1	2.9	4.0	5.0	6.2	7.1	8.0	9.3	10.2	11.0	12.0
AFTER	1	.6	1.4	2.9	3.0	3.9	5.8	6.7	7.6	8.5	9.4	10.3	11.0
PROJCT	2	.8	1.5	3.0	4.0	5.0	6.0	6.9	7.9	8.9	9.9	10.9	11.6
YEAR:	3	.8	1.7	3.1	4.0	5.2	6.2	7.1	8.0	9.0	10.0	11.0	12.0
1968	4	1.2	2.1	2.9	4.0	5.0	6.2	7.1	8.0	9.3	10.2	11.0	12.0

GRADE LEVELS IN MATHEMATICS

	POP TYPE	GRADE 1	2	3	4	5	6	7	8	9	10	11	12
BEFORE	1	.5	1.1	1.8	2.3	3.0	3.6	4.4	5.0	5.8	6.3	7.0	7.7
PROJCT	2	.8	1.3	2.2	2.9	4.0	4.6	5.5	6.1	7.0	8.0	8.1	8.6
YEAR:	3	.9	1.5	2.7	3.1	4.1	5.0	6.7	6.6	7.2	8.0	8.1	8.8
1965	4	1.0	2.0	2.9	3.9	5.0	6.2	7.1	8.0	9.1	10.0	11.1	12.0
AFTER	1	.5	1.3	2.2	3.0	4.0	4.6	5.4	6.0	6.7	7.2	8.0	8.8
PROJCT	2	.8	1.8	2.9	3.9	5.0	5.6	6.5	7.1	8.1	8.4	8.5	9.0
YEAR:	3	.9	2.0	3.0	4.1	5.0	6.0	7.0	8.0	8.8	9.0	9.1	9.4
1968	4	1.0	2.1	3.0	4.2	5.1	6.0	7.0	8.0	9.0	10.0	11.0	12.0

GRADE LEVELS IN SCIENCE

	POP TYPE	GRADE 1	2	3	4	5	6	7	8	9	10	11	12
BEFORE	1	.6	1.4	2.9	3.0	3.9	5.8	6.7	7.6	8.5	9.4	10.3	11.0
PROJCT	2	.8	1.5	3.0	4.0	5.0	6.0	6.9	7.9	8.9	9.9	10.9	11.6
YEAR:	3	.8	1.7	3.1	4.0	5.2	6.2	7.1	8.0	9.0	10.0	11.0	12.0
1965	4	1.2	2.1	2.9	4.0	5.0	6.2	7.1	8.0	9.3	10.2	11.0	12.0
AFTER	1	.6	1.1	1.6	2.3	3.0	3.8	4.5	5.2	7.0	7.6	8.2	8.9
PROJCT	2	.8	1.2	1.9	2.9	3.4	4.5	5.1	6.0	7.7	8.4	9.3	10.0
YEAR:	3	.8	1.3	2.0	3.1	3.7	4.9	5.8	6.6	8.6	9.2	9.9	10.9
1968	4	1.2	2.1	2.9	4.0	5.0	6.2	7.1	8.0	9.3	10.2	11.0	12.0

POP TYPES:
1-NONWHITES, LESS THAN 2000
2-NONWHITES, MORE THAN 2000
3-WHITES, LESS THAN 2000
4-WHITES, MORE THAN 2000

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PART II

THE SCHOOL SUBMODEL

Prepared for the Division of Operations Analysis

by

Abt Associates, Inc.
Under Contract No. OEC 1-6-001681-1681

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TN-19 Part VI - The Effectiveness Submodel

TN-20 Part VII- The Simulation

The model was developed by Abt Associates, of Cambridge, Massachusetts, for the Division of Operations Analysis, National Center for Educational Statistics, under contract number OEC 1-6-001681-1681.

THE SCHOOL SUBMODEL

The School Submodel is similar to a production process with quality controls. The inputs of four student types (white and non-white, above and below $2,000 family income) and education resources (teachers, equipment, facilities, community environment) are transformed into better educated individuals, graduates and dropouts. Inputs include Title I programs, previous school achievement and student sociological data, and specific improved achievement in the target population. Outputs are the change in numbers of graduates, dropouts, achievement levels by age or grade, and critical achievement areas.

There are five subroutines: the school flow matrix, course of study selection and allocation, truancy and dropout, and graduation (see Fig. 1). The school flow matrix represents the flow of students through parallel achievement category tracks "sub-assembly production lines," in a sequence of achievement levels within each track "quality control checkpoints." The achievement categories in various combinations form subjects such as math or English. The achievement levels may represent grades or promotion thresholds (where schools are graded), but in any case are prerequisite gates for further achievement in the same and in related achievement categories. Any combination of achievement categories, achievement levels, and student types may be the target area of a Title I program (see Fig. 2).

At the eighth grade achievement level of the school flow matrix, the course of study selection routine is usually triggered. Students are allocated to college prep, clerical, general, or vocational high school courses of study, depending on their achievement levels and the entry requirements.

Truancy and absence rates are computed at all achievement or grade levels on the basis of external attitudinal and past achievement data. Dropouts are computed on the basis of past achievement, absence, attitudes, and community factors. Graduates are computed on the basis of achievement at the final level or grade, and graduation criteria. Finally, critical achievement areas, in terms of age/grade and subject and population, can be identified by iterated runs of the school flow matrix under various conditions. -/-

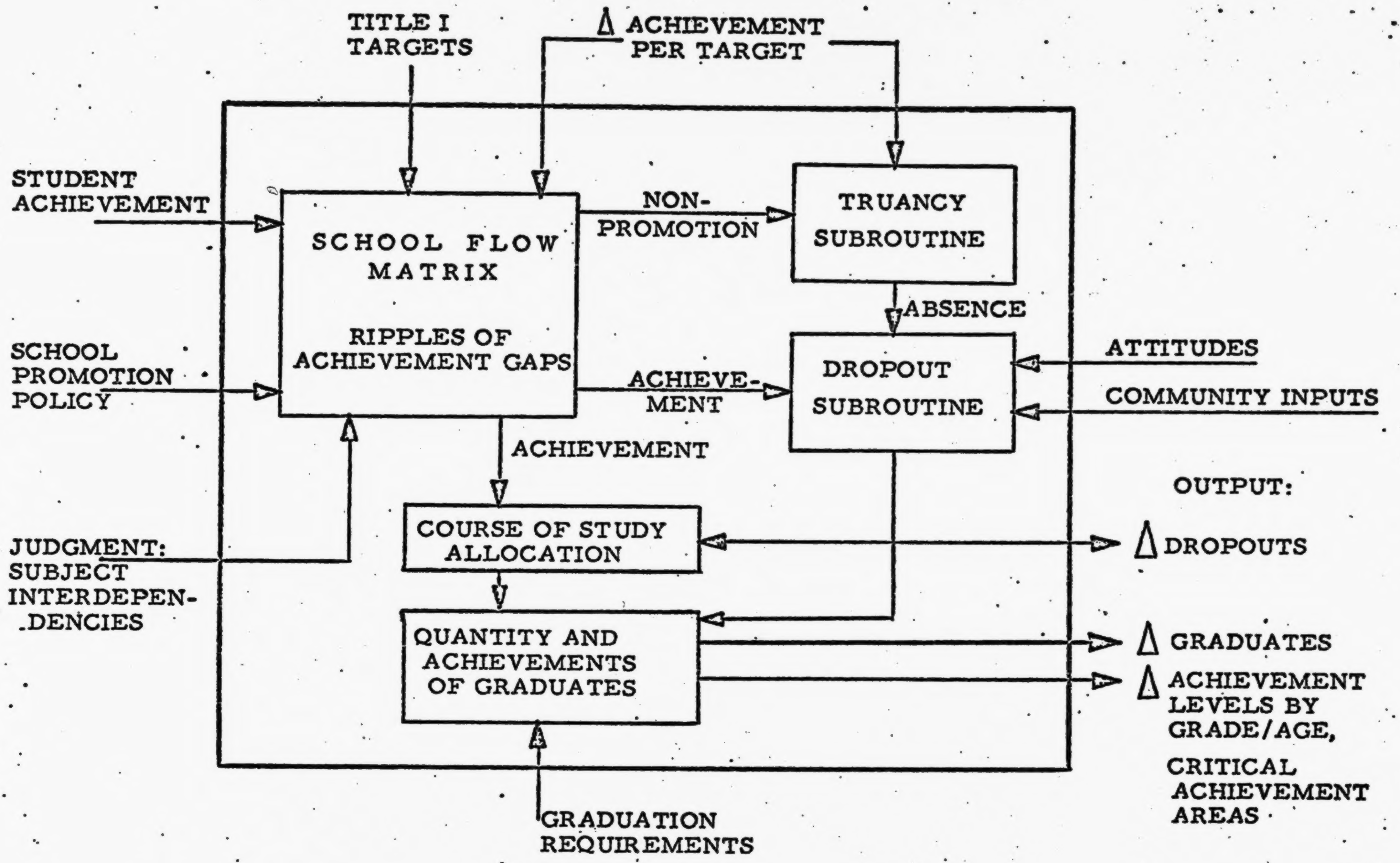
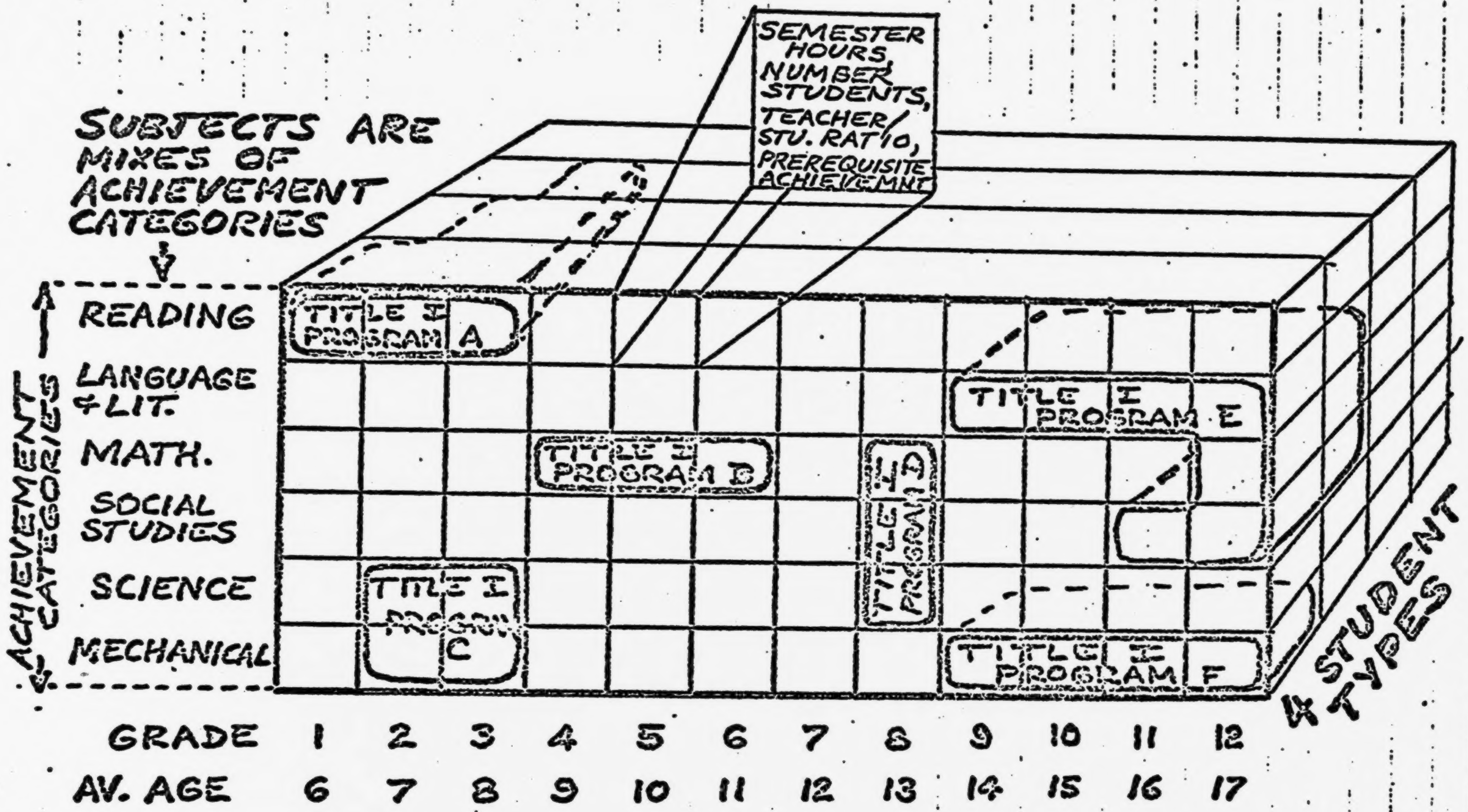

TITLE I TARGETS
Δ ACHIEVEMENT PER TARGET
STUDENT ACHIEVEMENT
SCHOOL FLOW MATRIX
RIPPLES OF ACHIEVEMENT GAPS
NON-PROMOTION
TRUANCY SUBROUTINE
ABSENCE
DROPOUT SUBROUTINE
ATTITUDES
COMMUNITY INPUTS
SCHOOL PROMOTION POLICY
ACHIEVE-MENT
ACHIEVEMENT
OUTPUT:
COURSE OF STUDY ALLOCATION
Δ DROPOUTS
JUDGMENT: SUBJECT INTERDEPEN-DENCIES
QUANTITY AND ACHIEVEMENTS OF GRADUATES
Δ GRADUATES
Δ ACHIEVEMENT LEVELS BY GRADE/AGE,
CRITICAL ACHIEVEMENT AREAS
GRADUATION REQUIREMENTS

FIG. 1 SCHOOL SUBMODEL


SUBJECTS ARE MIXES OF ACHIEVEMENT CATEGORIES
SEMESTER HOURS, NUMBER STUDENTS, TEACHER/STU. RATIO, PREREQUISITE ACHIEVEMNT
READING
LANGUAGE & LIT.
MATH.
SOCIAL STUDIES
SCIENCE
MECHANICAL
ACHIEVEMENT CATEGORIES
TITLE I PROGRAM A
TITLE I PROGRAM B
TITLE I PROGRAM C
TITLE I PROGRAM D
TITLE I PROGRAM E
TITLE I PROGRAM F
4 STUDENT TYPES
GRADE 1 2 3 4 5 6 7 8 9 10 11 12
AV. AGE 6 7 8 9 10 11 12 13 14 15 16 17

TYPICAL TARGET STUDENT POPULATIONS
IN THE SCHOOL FLOW MATRIX

FIG. 2

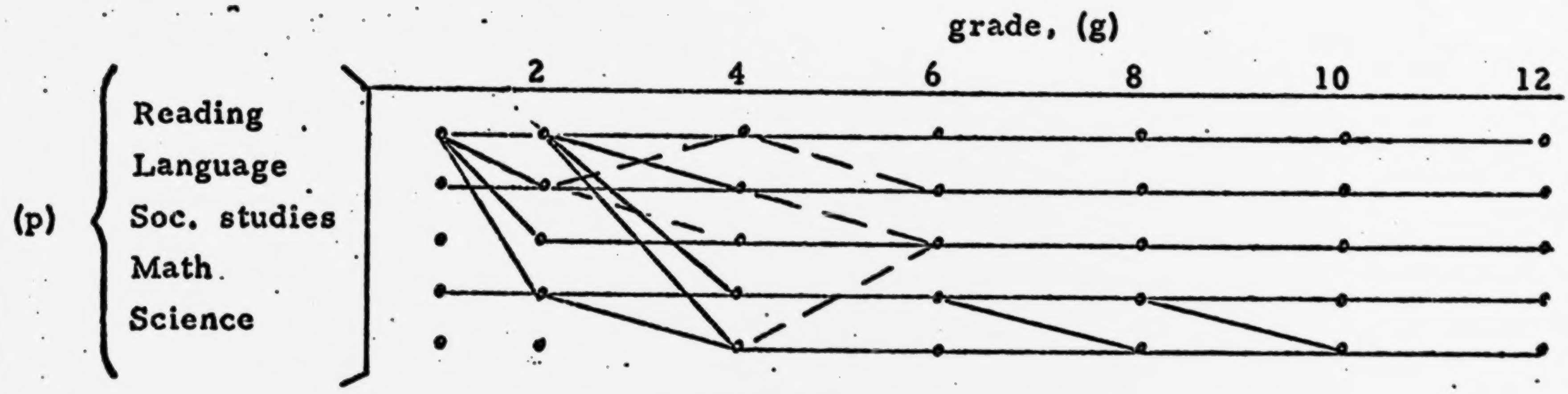
THE SCHOOL FLOW NETWORK

Introduction

Forecasting long-range education effects as a result of Title I is accomplished in the school model by propagating changes in achievement resulting from the application of those Title I programs. The propagation starts at the next highest grade and works forward by the successive application of a set of decision rules. The decision rules are based on predicted performance as a result of meeting curriculum prerequisites. The past performance for each student type and course type is stored. The school flow network is overlayed upon the historic data. The achievement change is then overlayed upon the network, propagated, and an upgraded performance profile is generated.

Description

The school flow network consists of nodes at each grade/age achievement point. Nodes are connected by solid lines to indicate a primary prerequisite exists in the previous grade for that achievement category. Dotted lines indicate that the previous grade acts as a secondary prerequisite in that achievement category.



The school flow network is used to infer the results of a Title I program on graduates and drop-outs. For example, if a Title I program is designed to improve the reading level achievement of second graders, this improvement will result in an increased chance of improvement in most other fourth grade achievements (except possibly, 'shop'). The network provides the prerequisites, and the historical achievement scores provide the basis for extrapolating 'downstream' effects.

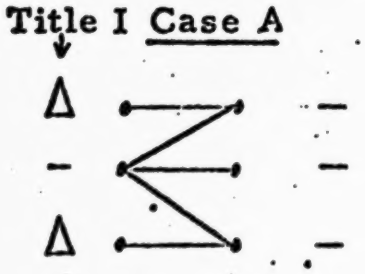
Assumptions About Network Propagation

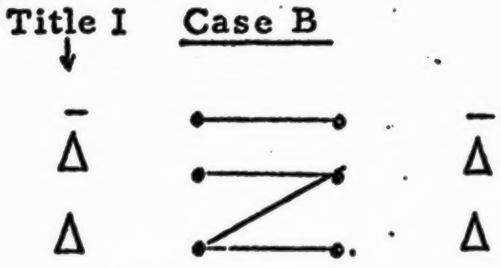
The network is designed to operate in conjunction with a Title I program aimed at upgrading achievement. Several assumptions about operations are required:

1) We assume that in all cases:

$\Delta A_{p,g}$ requires $\Delta A_{p,\,g-1}$, that is, a change in any achievement (A_p) for any grade (g) requires the presence of a change in the same achievement at the previous grade. This is the horizontal prerequisite.

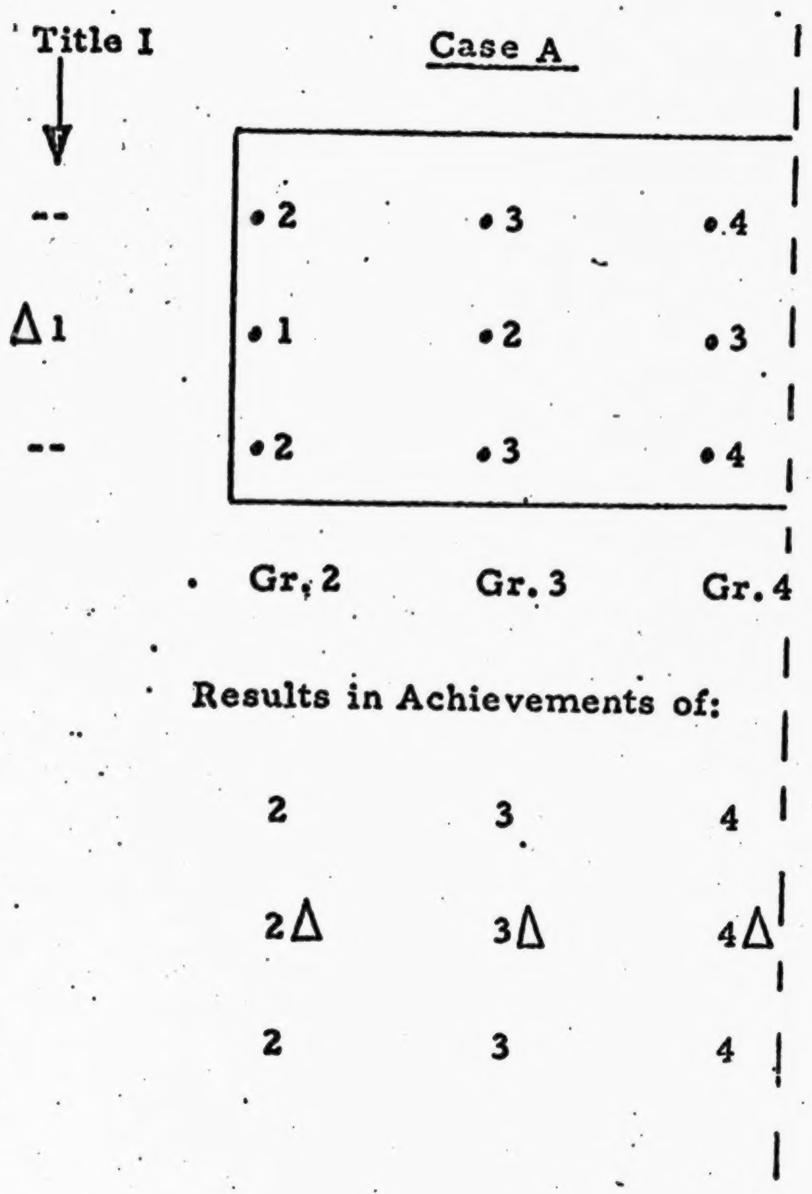
2) We assume that, in all cases, any lost requirement prevents a change in achievement at the next level. This is the gating function effect. The result is that any node having more than one prerequisite must have a change present on all its entry lines to assure passing a change to the next higher level. (If only weak prerequisities are not present, we may reduce the probability of a change to the next level.)

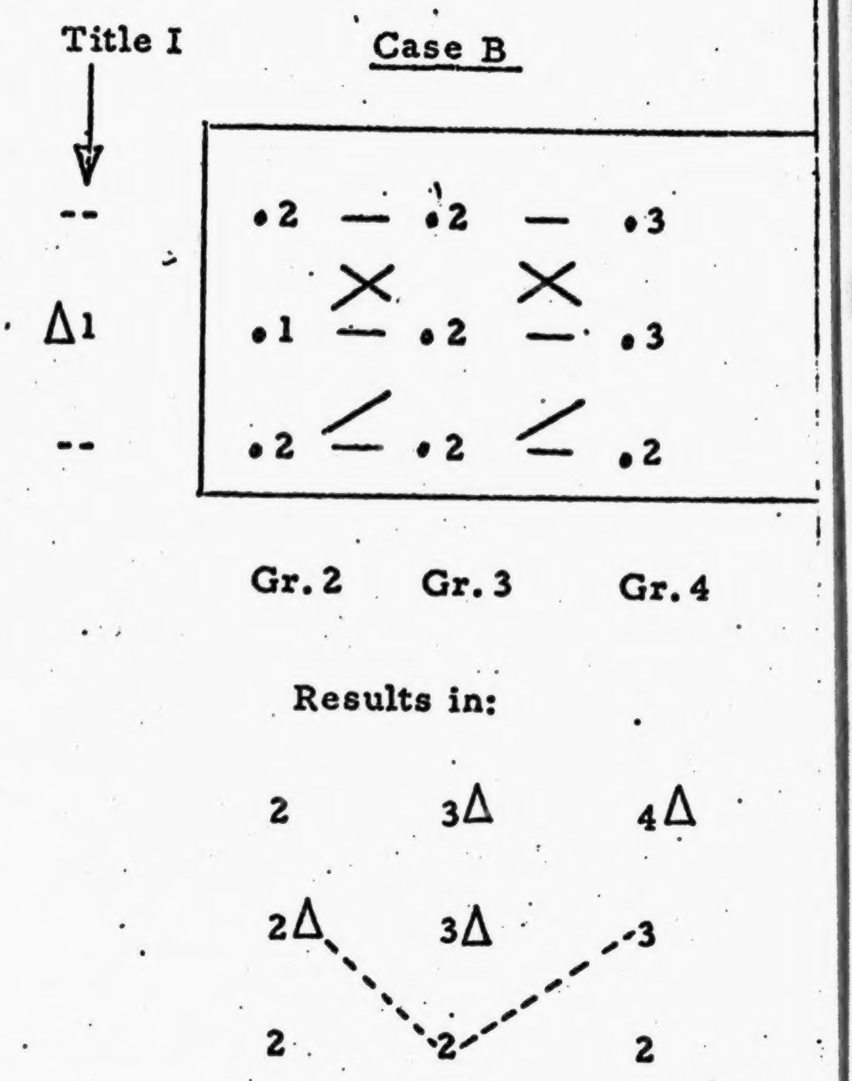




3) The "ripple effect" can die out after a few grades if insufficient nodes have been activated.

4) A change will be generated whenever the level of the prerequisite is higher than or equal to the next level and the line is a diagonal. This assumption prevents the change from "washing-out" further up the network due to loss of only one of the requisites.


Title I
Case A
--
Δ1
--
•2 •3 •4
•1 •2 •3
•2 •3 •4
Gr. 2 Gr. 3 Gr. 4
Results in Achievements of:
2 3 4
2Δ 3Δ 4Δ
2 3 4


Title I
Case B
--
Δ1
--
•2 — •2 — •3
•1 — •2 — •3
•2 — •2 — •2
Gr. 2 Gr. 3 Gr. 4
Results in:
2 3Δ 4Δ
2Δ 3Δ 3
2 2 2

In case A, the change was not propagated diagonally because the historic achievement indicates a lag in only the center subject. In case B, the change was propagated up by the earlier second grade achievement in the top subject, but was not propagated down because no network link was provided.

5) Only estimates of standard improvements are forecast by the network. No attempt has been made to analyze the historic data for enhancing effects which would allow faster achievements due to superior facilities or teachers further up the network. In other words, the network is sensitive to the correction of achievement gaps or deficiencies, but will not in its present simplified form reflect improvements from average to superior levels.

Network Operation

Each of the decision rules is applied at each of the network nodes beyond the nodes affected by Title I. Achievement performance is predicted for each population segment carried in the model. Drop-outs, secondary school course of study requirements, and expected graduates are based on the predicted performance.

Display

The "shadow effect" of early achievement failure and its removal or reduction after Title I programs will be displayed as shown in Figure I. The numbers represent level of achievement in terms of grade. The x's are used for graphical purposes to represent the shadow.

FIGURE I

LONG RANGE EDUCATIONAL EFFECTS

Before Title I:	Low Income - Negro											
Reading	x xKx x	x x1x x	x x1x x	x x2x x	x x2x x	x x3x x	x x3x x	x x4x x	x x4x x	x x4x x	x x4x x	x x4x x
Language	x	x xKx x	x x1x x	x x1x x	x x2x x	x x2x x	x x3x x	x x3x x	x x4x x	x x4x x	x x4x x	x x4x x
Soc. studies					x x1x x	x x2x x	x x3x x	x x4x x	x x4x x	x x4x x	x x4x x	x x4x x
Math	x xKx x	x xKx x	x x1x x	x x1x x	x x2x x	x x2x x	x x3x x	x x3x x	x x4x x	x x4x x	x x4x x	x x4x x
Science					x x1x	x x2x	x x3x	x x4x	x x4x	x x4x	x x4x	x x4x
	1	2	3	4	5	6	7	8	9	10	11	12

grade

Title I Program: Headstart for Low Income - Negro

Reading	1	2	3	4	5	6	7	8	x x8x x	x x8x x	x x8x x	x x8x x
Language		2	3	4	5	x x5x x	x x6x x	x x7x x	x x7x x	x x7x x	x x7x x	x x7x x
Soc. studies					5	6	x x6x x	x x6x x	x x7x x	x x7x x	x x7x x	x x7x x
Math	x xKx x	x x1x x	x x2x x	x x3x x	x x4x x	x x5x x	x x6x x	x x7x x	x x7x x	x x7x x	x x7x x	x x7x x
Science					x x3x	x x4x	x x5x	x x6x	x x7x	x x7x	x x7x	x x7x
	1	2	3	4	5	6	7	8	9	10	11	12

grade

The shadow cast over the entire performance before headstart has been partially removed. Remedial Arithmetic would further increase achievement but secondary school failure may still be possible due to low relative achievement and poor attitude toward school.

THE USE OF ACHIEVEMENT TEST SCORES

The achievement test scores to be used as data by the model (e.g. Standford Achievement Test, STEP, Iowa MP, etc.) will provide statistical distributions of scores by grade or age level. For example, the typically expected level of achievement of fourth graders in reading will be the mean level of achievement for the fourth grade. A student who scores, let us say, one standard deviation below the mean can be classified as a third grade reader; two standarddeviations above might constitute a sixth grade reading ability.

Each of the student types has a set of achievement scores (grade levels) for each grade determined from historic records. When the raw data are in terms other than grade level--for example, grades or percentiles--the scores are converted to grade level before being used in the model.

The network propagation results are maintained for each student type independently and can be combined later for a presentation of mean achievement and distribution by grade or age. Student types are defined as the bases of white (W) vs. non-white (N) and family income above \$2,000 vs. below \$2,000.

COURSE OF STUDY SELECTION SUBROUTINE

Early in his high school years the student may choose a course of study designed to prepare him for college, for commerce, or for the vocations. Some students develop their curriculums within these courses of study while others select a general course of study. The "Course of Study Selection Subroutine" indicates changes in Title I apportionment of students among the courses of study.

After a Title I input, students are allocated among the courses of study by reconciling the demand for each course of study with the supply of slots in that course of study. The student choices are made from a list of those courses of study for which he has the required record of achievement.

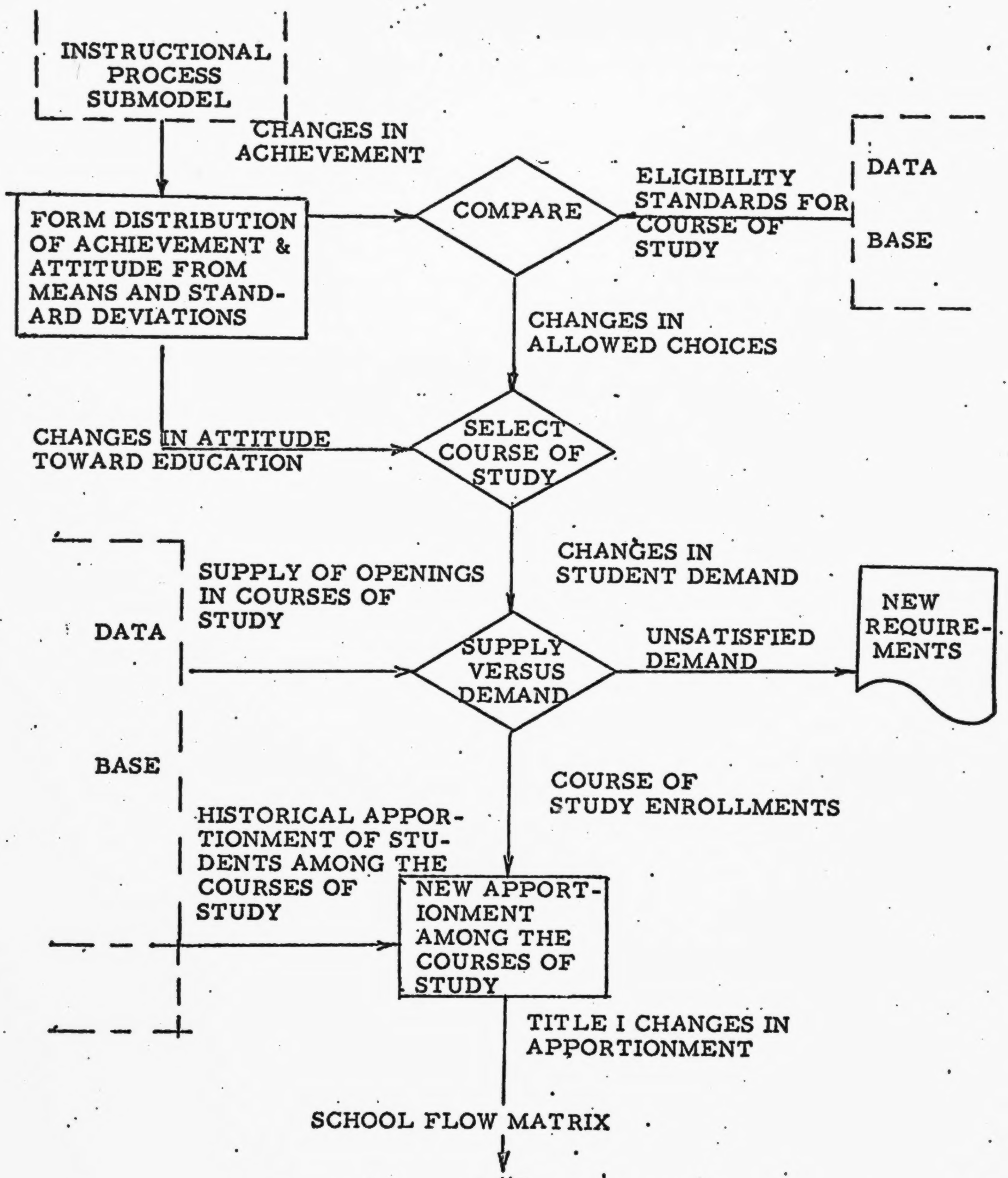
The student eligibility and preference for a course of study are based upon his characteristics. However, restricting the definition of student types to the average (mean) of the distributions of characteristics precludes simulating the process by which the various individuals within a student type select different courses of study. Therefore, it is necessary to distribute the characteristics which determine eligibility and preference along a distribution the shape of which is a judgmental input.

The minimum standards for eligibility are expressed in terms of required minimum levels of previous student achievement. The allowed student choices are those for which the student, generated from the distribution of characteristics for the student type, meets the minimum requirements. A list of allowed courses for that student is thereby created.

The student makes his actual choices, from this list of allowed choices, upon the basis of his attitude toward education. The course of study which is most compatible with the student attitude toward education is chosen.

The choices of individual students are aggregated to determine the total demand for the available openings in each course of study. A check is made to determine if the demand for any course of study is greater than the supply, the excess demands are eliminated by allocating the appropriate number of students among the unfilled openings according to their second preferences for allowed choices. An output report is generated when there is unfilled demand.

After supply and demand have been reconciled, or if the demand does not exceed the supply for any course, the changes in the apportionment of students among the courses of study is determined, by comparing the Title I apportionment with the historical apportionment.


INSTRUCTIONAL PROCESS SUBMODEL
CHANGES IN ACHIEVEMENT
FORM DISTRIBUTION OF ACHIEVEMENT & ATTITUDE FROM MEANS AND STANDARD DEVIATIONS
COMPARE
ELIGIBILITY STANDARDS FOR COURSE OF STUDY
DATA
BASE
CHANGES IN ALLOWED CHOICES
CHANGES IN ATTITUDE TOWARD EDUCATION
SELECT COURSE OF STUDY
CHANGES IN STUDENT DEMAND
SUPPLY OF OPENINGS IN COURSES OF STUDY
DATA
BASE
SUPPLY VERSUS DEMAND
UNSATISFIED DEMAND
NEW REQUIREMENTS
COURSE OF STUDY ENROLLMENTS
HISTORICAL APPORTIONMENT OF STUDENTS AMONG THE COURSES OF STUDY
NEW APPORTIONMENT AMONG THE COURSES OF STUDY
TITLE I CHANGES IN APPORTIONMENT
SCHOOL FLOW MATRIX

THE TRUANCY SUBROUTINE

The truancy subroutine computes an index of truancy for the grades 9 - 12. The truancy index is used to compute dropouts.

Research Findings

The following findings summarize the elements considered in our model of truancy.

Self

A study of truants (1) studied 338 truant students in San Francisco. Sixty percent of the students were boys. Their I.Q.'s averaged below normal. Average I.Q. for their schools were 100; their curve 95 (range 43 - 153). Student had low opinions of self, felt isolated.

School

53% of students were in junior high school
17% elementary
30% high school
70% had been left back at least once and were below average
All achieved an average of C grade or below.

Home

45% of the students came from disrupted or broken homes
50% of families received public assistance.

Outcomes

Truants were treated by case workers. Younger students in elementary levels improved their attendance rates after treatment. Older students showed no improvement.

Summary

Both this study and a British one (2) agree that the truant's family situation is poor economically and interpersonally. The school situation is poor: the student performs below average grade-wise and has been left behind. He responds by being out of school approximately 3 times as often as the non-truant.

---

(1) John L. Roberts, "Factors Associated with Truancy", Personnel and Guidance Journal, March, 1956, pp. 431-436.

(2) Maurice J. Tyerman, "Research in Truancy", British Journal of Educational Psychology, November, 1958, pp. 225-229.

The Model of Truancy

The following figure depicts the factors considered in computing the index of truancy. The factors are weighted and combined into an index of likelihood of a change in truant behavior. The index is compared to a threshold and will determine the actual change passed along to the dropout subroutine.

Equations for Computation

The change in truancy for grades 9 - 12 caused by a Title I program is computed as:

$$\Delta T_{t,g} = a_o * \left[a_1 * \frac{\sum_{p,cs} \Delta A_{p,t,g,cs}}{\sum_{p} p + \sum_{cs} cs} + a_2 * \frac{\sum_{cs} \Delta E_{t,g,cs}}{\sum_{cs} cs} \right]$$

where:

$\Delta T_{t,g}$ = change in truancy for student type (t) and grade (g)

$\Delta A_{p,t,g,cs}$ = change in target group achievement by category (p) type (t), grade (g) and course of study (cs)

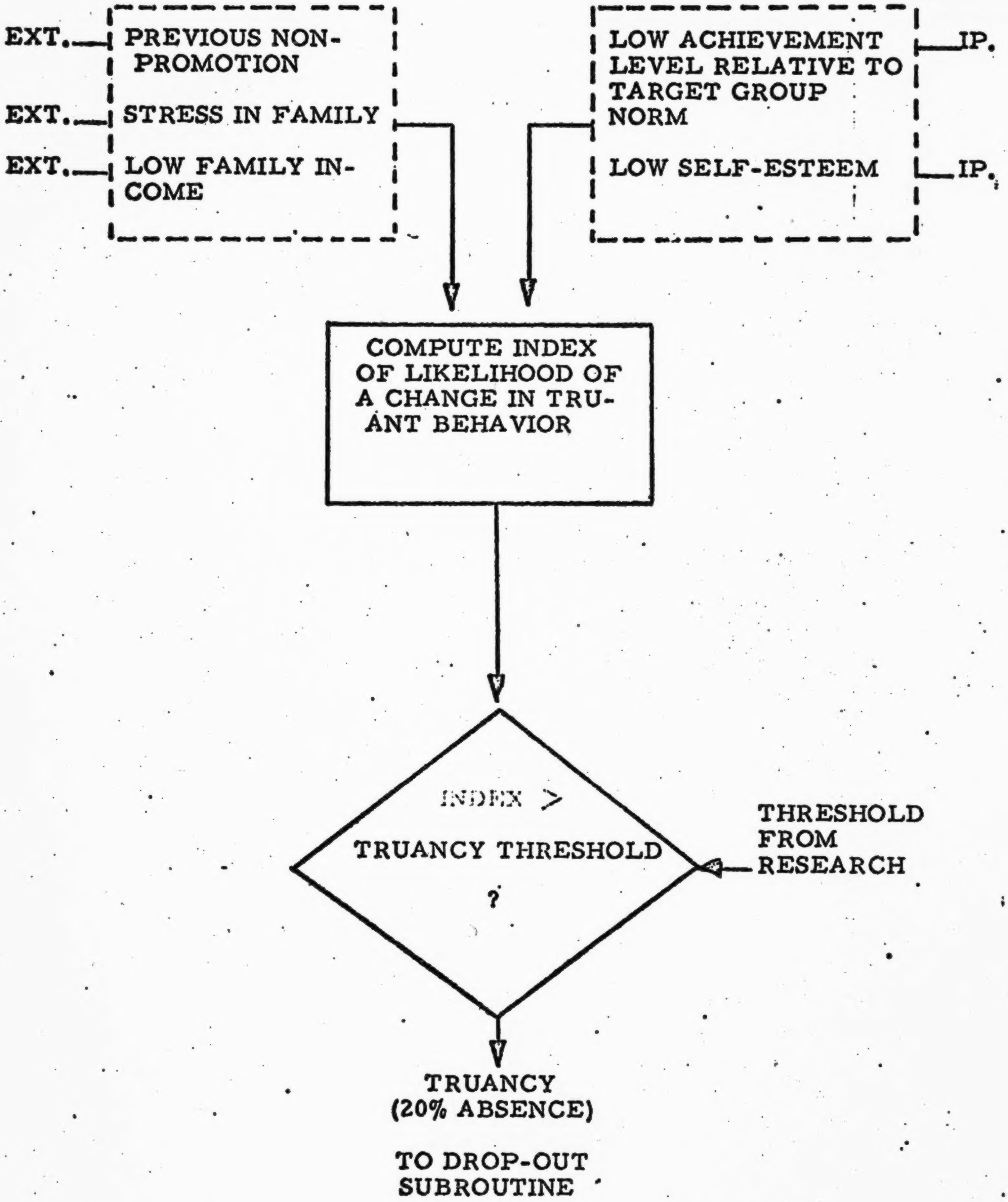
$\Delta E_{t,g,cs}$ = change in target-group Self-Esteem

a_o = Scaling parameter

a_1, a_2 = weighting coefficients

TRUANCY SUBROUTINE

INDICATORS OF POTENTIAL TRUANCY


EXT.
PREVIOUS NON-PROMOTION
EXT.
STRESS IN FAMILY
EXT.
LOW FAMILY INCOME
LOW ACHIEVEMENT LEVEL RELATIVE TO TARGET GROUP NORM
IP.
LOW SELF-ESTEEM
IP.
COMPUTE INDEX OF LIKELIHOOD OF A CHANGE IN TRUANT BEHAVIOR
INDEX >
TRUANCY THRESHOLD
?
THRESHOLD FROM RESEARCH
TRUANCY (20% ABSENCE)
TO DROP-OUT SUBROUTINE

DROPOUT SUBROUTINE

The change in dropouts as a result of the application of a Title I program is computed for each of the grades between 9 and 12 for each of the student types. The change is basically the difference between the historical dropouts who attended the school affected by Title I, and the dropouts anticipated from the neighborhood school after Title I.

Research Findings

The chief variables pointing to dropouts are:

Home

1. Family of Dropout

   a. Dropout rate of parent

   One study revealed that 78.5% of mothers dropped out.
   80.3% of fathers dropped out.
   Majority of parents had completed 9th grade or less.

   (Percy V. Williams, "Dropouts", NEA Journal, Feb., 1963, 11-12.)

   b. Dropout rate of siblings

   58% of dropouts come from families where all brothers and sisters dropped out.

   (Eli E. Cohen, "The Dropout Problem, A Growing Educational Concern", National Association of Secondary School Principals Bulletin, April 1961.)

2. Occupation of Parent

   Majority of parents of dropouts were unskilled or unemployed.

   (Morris Williams, "What Are the Schools Doing about School Leavers", NASSP Bulletin, XXXVII, 1953, p. 54.)

3. Divorce Rate in Family

   Many dropouts come from broken homes.

School

4. Reading Competency

   Ruth Penty studied 1169 ninth graders entering 10th grade--593 in poorest quartile and 593 in top quartile as readers. (Poor readers ranged 4.3 - 6.9 on reading test per grade level.)

   49.9% of the poor readers and 14.5% of the good readers left school in the 10th grade.

45.5% of the poor readers graduated as compared to 81.2% of the good readers.

Dropouts peaked in 10th grade.

(Ruth C. Penty, Reading Ability of High School Dropouts, New York, Teachers' College, Columbia University, 1956.)

5. Failure in Academic Subjects

   Most dropouts are failing.
   Most failures occur in 1st, 2nd and 9th grades.

6. Dropouts Do Not Participate in extra curricular school activities.

   85% rated low in participation
   60% isolated

   (Livingston A. Hugh, "High School Graduates and Dropouts, A New Look at a Persistent Problem," School Review LXVI (1958) 195-203)

7. Attendance

   More truancy and more long periods of absences in dropout than graduate history.

8. Transfer

   Many dropouts transferred from other schools.
   More transfers than in graduate population.

9. Dropout has few friends in school, associates with older youngsters and does not feel he belongs.

Variables not important between dropouts and non-dropouts:

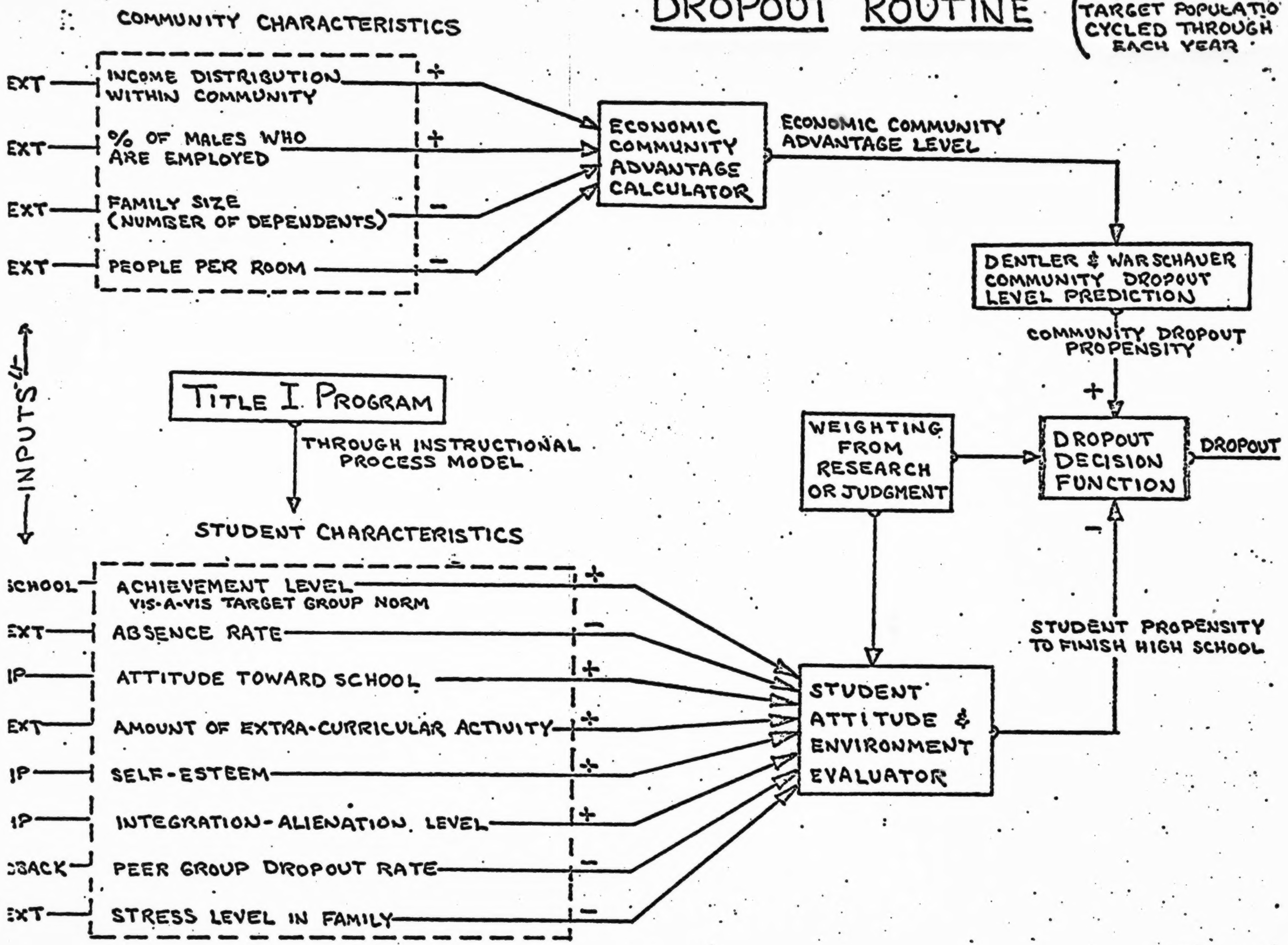
I.Q. - Penty study showed median I.Q. of dropouts average--not significant difference from graduating groups.

(Bert I. Greene, Eastern Michigan University's Work Shop on the Dropout, Eastern Michigan University, 1963.)

Model of Dropouts

The figure on the following page depicts the interaction of the basic factors used in the model. Community characteristics describing the economic advantages available in the community are compared with student attitudes and behavior to predict the change in dropouts.

DROPOUT ROUTINE


TARGET POPULATIO
CYCLED THROUGH
EACH YEAR
COMMUNITY CHARACTERISTICS
EXT
INCOME DISTRIBUTION WITHIN COMMUNITY
+
EXT
% OF MALES WHO ARE EMPLOYED
+
EXT
FAMILY SIZE (NUMBER OF DEPENDENTS)
−
EXT
PEOPLE PER ROOM
−
ECONOMIC COMMUNITY ADVANTAGE CALCULATOR
ECONOMIC COMMUNITY ADVANTAGE LEVEL
DENTLER & WARSCHAUER COMMUNITY DROPOUT LEVEL PREDICTION
COMMUNITY DROPOUT PROPENSITY
+
INPUTS
TITLE I. PROGRAM
THROUGH INSTRUCTIONAL PROCESS MODEL
STUDENT CHARACTERISTICS
WEIGHTING FROM RESEARCH OR JUDGMENT
DROPOUT DECISION FUNCTION
DROPOUT
−
SCHOOL
ACHIEVEMENT LEVEL VIS-A-VIS TARGET GROUP NORM
+
EXT
ABSENCE RATE
−
IP
ATTITUDE TOWARD SCHOOL
+
EXT
AMOUNT OF EXTRA-CURRICULAR ACTIVITY
+
IP
SELF-ESTEEM
+
IP
INTEGRATION-ALIENATION LEVEL
+
BACK
PEER GROUP DROPOUT RATE
−
EXT
STRESS LEVEL IN FAMILY
−
STUDENT ATTITUDE & ENVIRONMENT EVALUATOR
STUDENT PROPENSITY TO FINISH HIGH SCHOOL

Dropout Decision Function

We define the dropout decision function, $\Theta = \Theta(s)$ where s is any student, and

$\Theta > 0$ implies that student s drops out,

$\Theta \leq 0$ implies that student s stays in.

$$\Theta = D(A) \cdot (K_D P_D - K_F P_F) + K_o$$

where A is the present age of student s;

D(x) is the probability that a student who is going to drop out will drop out at age x;

P_D is the community dropout propensity;

P_F is the student's propensity to finish high school;

and K_D, K_F, K_o are appropriately chosen constants,

$K_D > 0, \quad K_F > 0.$

GRADUATION COMPUTATION

We wish to compute the expected change in the number of graduates to be expected from increased academic achievement in the Title I target group. Basically, we need several historically derived sets of data.

1. The numbers of last year's graduates who were previously enrolled in the target population school by student type ;

2. The set of minimum acceptable achievement levels by category for graduation.

3. The number of students directly affected by Title I by student type.

4. The propagated achievements of the target group in the twelfth grade.

The equation for the expected graduation change is:

$$\Delta GRAD_t = N_t - GR_t \text{ if } \left(\prod_{p,\,cs} \left[DIM\,(A_{p,\,12,\,t,\,cs} - G_p) \right] \neq 0 \right)$$

where:

$\Delta GRAD_t$ = Change in graduates by student type (t)

N_t = Number of students by type in the target population.

GR_t = Last year's graduates from the target neighborhood schools by student type.

$A_{p,\,12,\,t,\,cs}$ = Propagated Achievement by category (p), for the twelfth grade (12), by student type (t), and by course of study (cs)

G_p = Minimum acceptable achievement by category for graduation.

DIM = Function which computes the positive difference or zero.

Working Paper
Does Not Reflect
Official Policy of
The Office of Education

NATIONAL CENTER FOR EDUCATIONAL STATISTICS
Division of Operations Analysis

A COST-EFFECTIVENESS MODEL FOR THE ANALYSIS OF TITLE I ESEA PROJECT PROPOSALS

PART III

THE INSTRUCTIONAL PROCESS SUBMODEL

Prepared for the Division of Operations Analysis

by

Abt Associates, Inc.
Under Contract No. OEC 1-6-001681-1681

Technical Note
Number 16
December 9, 1966

OFFICE OF EDUCATION/U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

NATIONAL CENTER FOR EDUCATIONAL STATISTICS
Alexander M. Mood, Assistant Commissioner

DIVISION OF OPERATIONS ANALYSIS
David S. Stoller, Director

PREFACE

This Technical Note is the third part of a seven-part issue which describes a Cost-Effectiveness Model for the analysis of Title I ESEA Project Proposals. The seven parts are:

TN-14 Part I - An Overview of the Cost-Effectiveness Model and Submodels for the Evaluation of Title I ESEA Proposals

TN-15 Part II - The School Submodel

TN-16 Part III- The Instructional Process Submodel

TN-17 Part IV - The Community Submodel

TN-18 Part V - The Cost Submodel

TN-19 Part VI - The Effectiveness Submodel

TN-20 Part VII- The Simulation

The model was developed by Abt Associates, of Cambridge, Massachusetts, for the Division of Operations Analysis, National Center for Educational Statistics, under contract number OEC 1-6-001681-1681.

THE INSTRUCTIONAL PROCESS SUBMODEL

From the Cost-Effectiveness Model overview it should be apparent that the principal thrust of a Title I project is directed at the student himself. Notwithstanding the impact of Title I funds on the community as a whole, the primary emphasis of Title I is the improvement of individual personalities and achievements. As a result a fundamental process in the overall Education Cost-Effectiveness Model is the determination of the differential scholastic effects of alternate Title I proposals. This computation is carried out by the Instructional Process Submodel (see Chart I), which accepts the changes in the school environment wrought by the proposed project, and converts these changes into expected educational outcomes. These outcomes are then sent on to the School Submodel, where they are aggregated and their effects projected over time, and similarly to the Community Submodel where they affect the community propensities for social and cultural change. Underlying the Instructional Process Submodel is the hypothesis that the culturally-disadvantaged child initially fails in school because he is not sensitized to the scholastic environment. The student perceives his immediate world as the only relevant one, and that the language forms and cultural norms extant in the classroom are totally remote. He falls behind very early in his school career, receives no incentive to make up the gap, falls back even further, and often drops out of the system altogether. Title I is devoted to the reversal of this trend, and some of its effects are estimated in the Instructional Process.

Charts II and III illustrate the logic of the Instructional Process Model. Title I Project Description data is received by the School Submodel, and makes changes in both the curriculum and operating conditions. Then the School Submodel compares the pre- and post-Title I conditions, and the differences are used to evaluate the extent to which the target population will become more sensitized to the academic environment. The sensitivity indicators are what may be called "Learning

COST-EFFECTIVENESS MODEL OVERVIEW

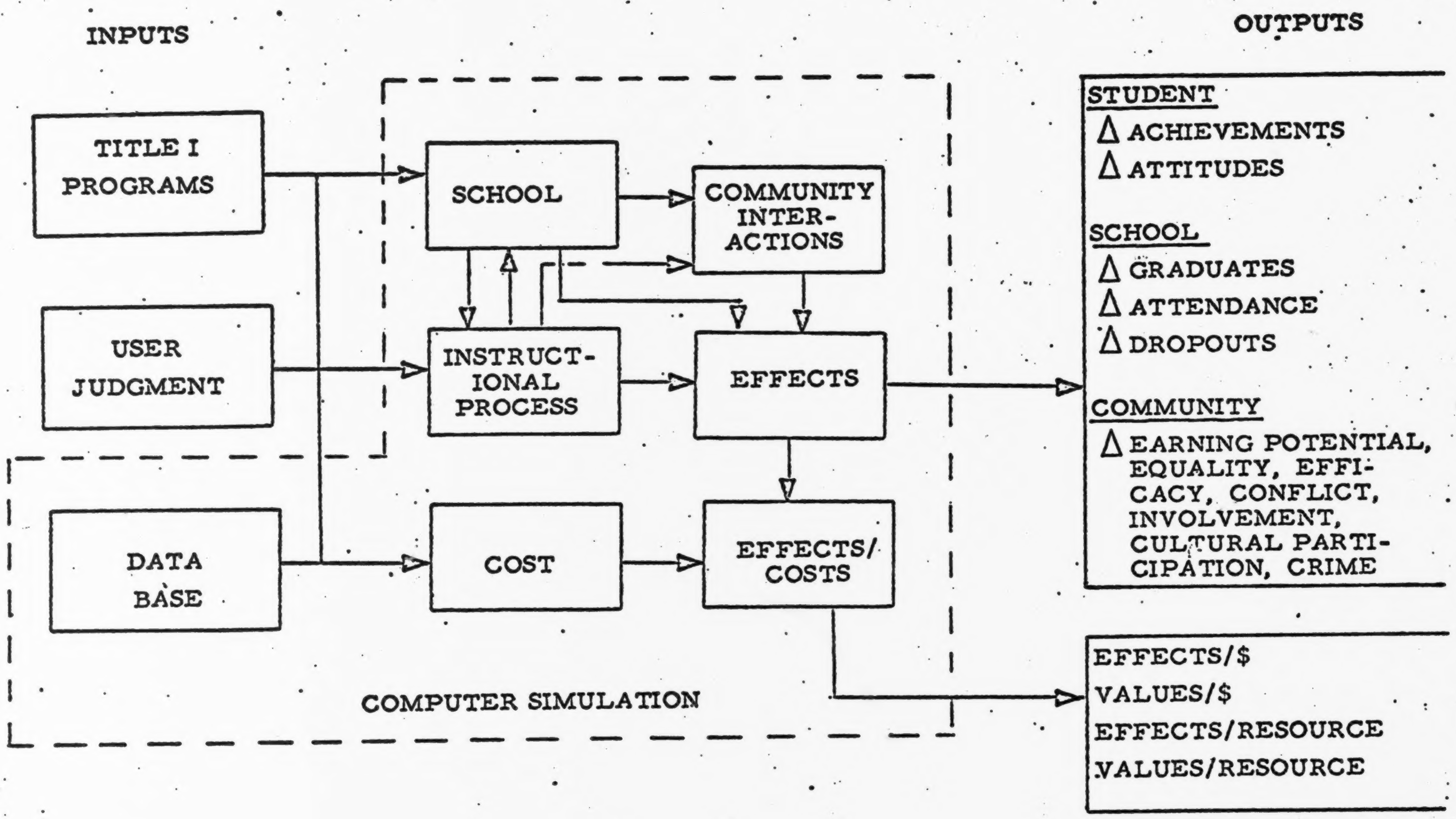

INPUTS
OUTPUTS
TITLE I PROGRAMS
USER JUDGMENT
DATA BASE
SCHOOL
INSTRUCTIONAL PROCESS
COST
COMMUNITY INTERACTIONS
EFFECTS
EFFECTS/COSTS
COMPUTER SIMULATION
STUDENT
Δ ACHIEVEMENTS
Δ ATTITUDES
SCHOOL
Δ GRADUATES
Δ ATTENDANCE
Δ DROPOUTS
COMMUNITY
Δ EARNING POTENTIAL, EQUALITY, EFFICACY, CONFLICT, INVOLVEMENT, CULTURAL PARTICIPATION, CRIME
EFFECTS/$
VALUES/$
EFFECTS/RESOURCE
VALUES/RESOURCE

CHART I

INSTRUCTIONAL PROCESS

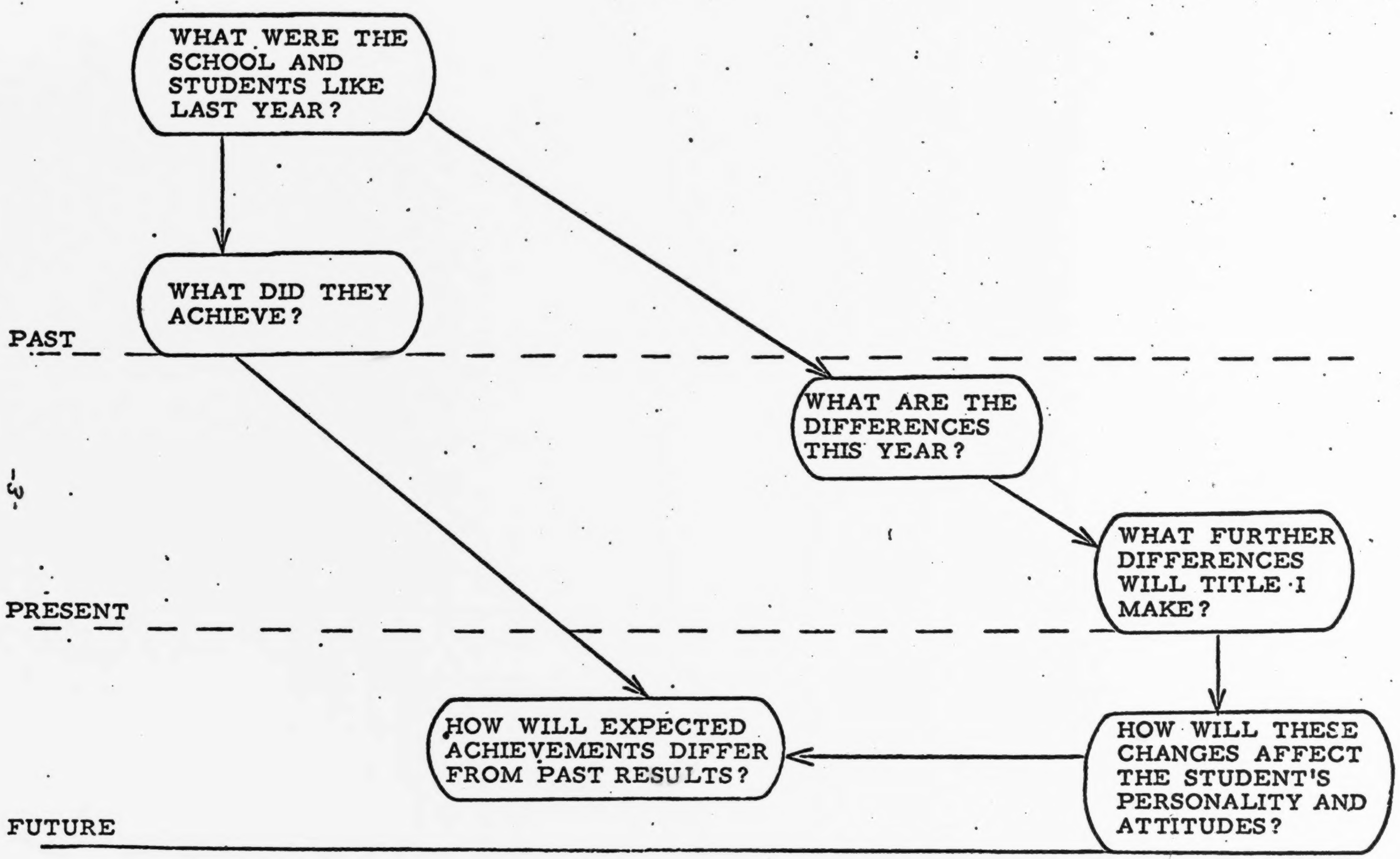

WHAT WERE THE SCHOOL AND STUDENTS LIKE LAST YEAR?
WHAT DID THEY ACHIEVE?
PAST
WHAT ARE THE DIFFERENCES THIS YEAR?
WHAT FURTHER DIFFERENCES WILL TITLE I MAKE?
PRESENT
HOW WILL EXPECTED ACHIEVEMENTS DIFFER FROM PAST RESULTS?
HOW WILL THESE CHANGES AFFECT THE STUDENT'S PERSONALITY AND ATTITUDES?
FUTURE

CHART II

INSTRUCTIONAL PROCESS

OVERVIEW

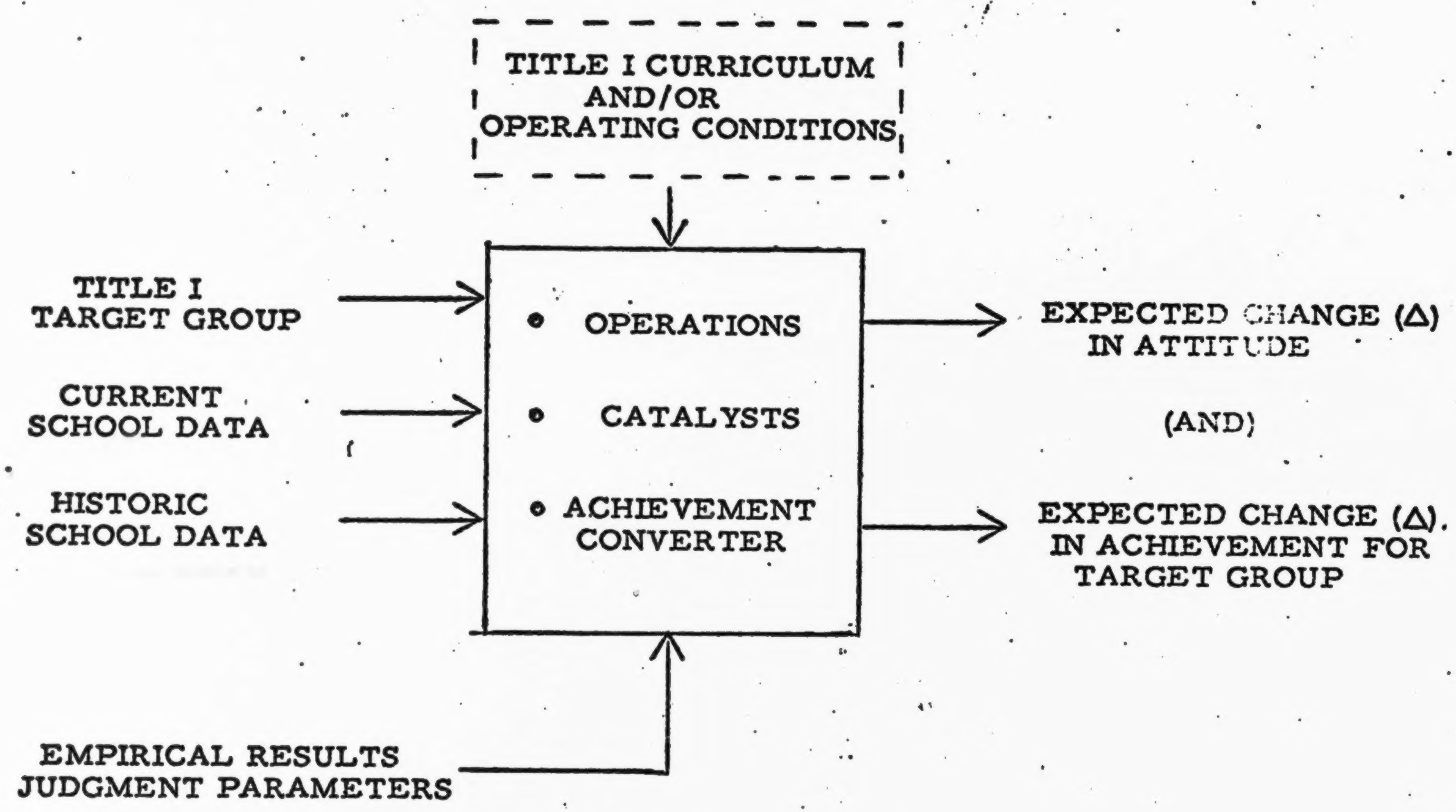

TITLE I CURRICULUM AND/OR OPERATING CONDITIONS
TITLE I TARGET GROUP
CURRENT SCHOOL DATA
HISTORIC SCHOOL DATA
• OPERATIONS
• CATALYSTS
• ACHIEVEMENT CONVERTER
EXPECTED CHANGE (Δ) IN ATTITUDE
(AND)
EXPECTED CHANGE (Δ) IN ACHIEVEMENT FOR TARGET GROUP
EMPIRICAL RESULTS JUDGMENT PARAMETERS

CHART II-a

INSTRUCTIONAL PROCESS

DETAIL

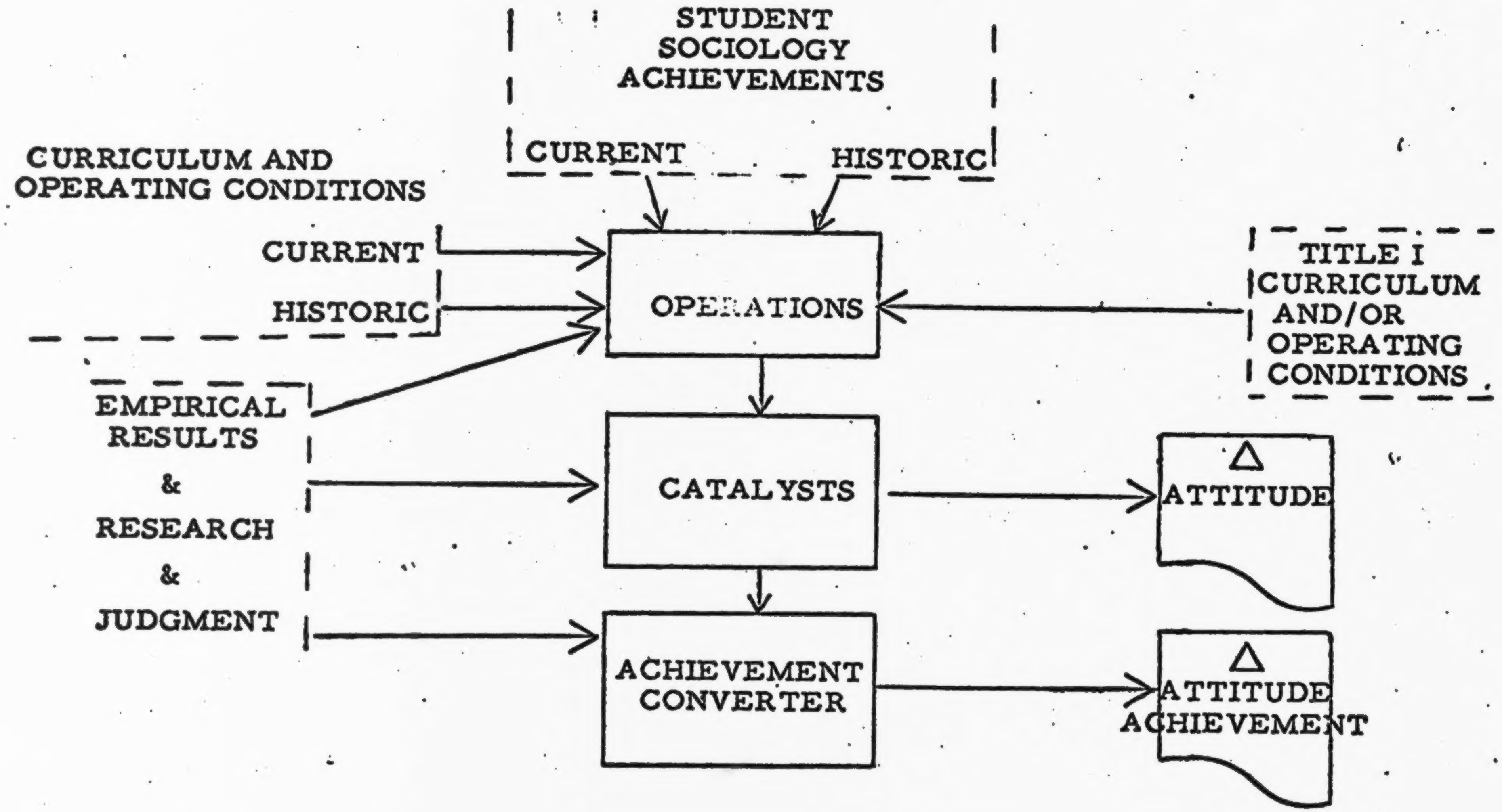

STUDENT SOCIOLOGY ACHIEVEMENTS
CURRENT
HISTORIC
CURRICULUM AND OPERATING CONDITIONS
CURRENT
HISTORIC
OPERATIONS
TITLE I CURRICULUM AND/OR OPERATING CONDITIONS
EMPIRICAL RESULTS & RESEARCH & JUDGMENT
CATALYSTS
Δ ATTITUDE
ACHIEVEMENT CONVERTER
Δ ATTITUDE ACHIEVEMENT

CHART III

catalysts," or accelerators of the learning process. These "catalysts" consist of a set of personality characteristics which, if stimulated at certain stages of the student's development, will greatly enhance his educational productivity. (See Chart IV.) Expected change in student productivity is computed in Scholastic Achievements as measured by standardized tests.* These test scores, in addition to the changes in learning catalysts, are the outputs of the Instructional Process Submodel, and the fundamental indicators of the Title I impact on the student population (See Chart V).

Clearly, the mathematical equations that transform changes in the environment to changes in student attitudes, personality, and achievements are difficult to formulate on the basis of current research. Consequently, these relationships will initially be calibrated with empirical data collected from school records, and, if possible, from Title I Case Histories.

First, the curriculum node to be affected by Title I is defined (by subject, grade, student types, teacher/student ratio, and time allocation). Then, assuming the subject is not new to the school, the same curriculum node characteristics are defined for the previous year. If there are no differences between curriculum node descriptions for both the past and the present year, then the same amount of achievement change for each student type as occurred last year can be expected. On the other hand, if the student populations, or the curriculum contents, or the operating conditions, are different for the two nodes, then these differences can be correlated with the learning catalysts, and these in turn with scholastic achievements. The model will then compute the expected outcomes, and these can be checked with the actual achievements of the previous year's student population. The internal relationships among model variables can thus be calibrated by successive tunings until the predictions approximate the empirical results. When Title I is introduced, these same relationships are assumed to hold, and environmental changes are similarly converted into expected educational outcomes.

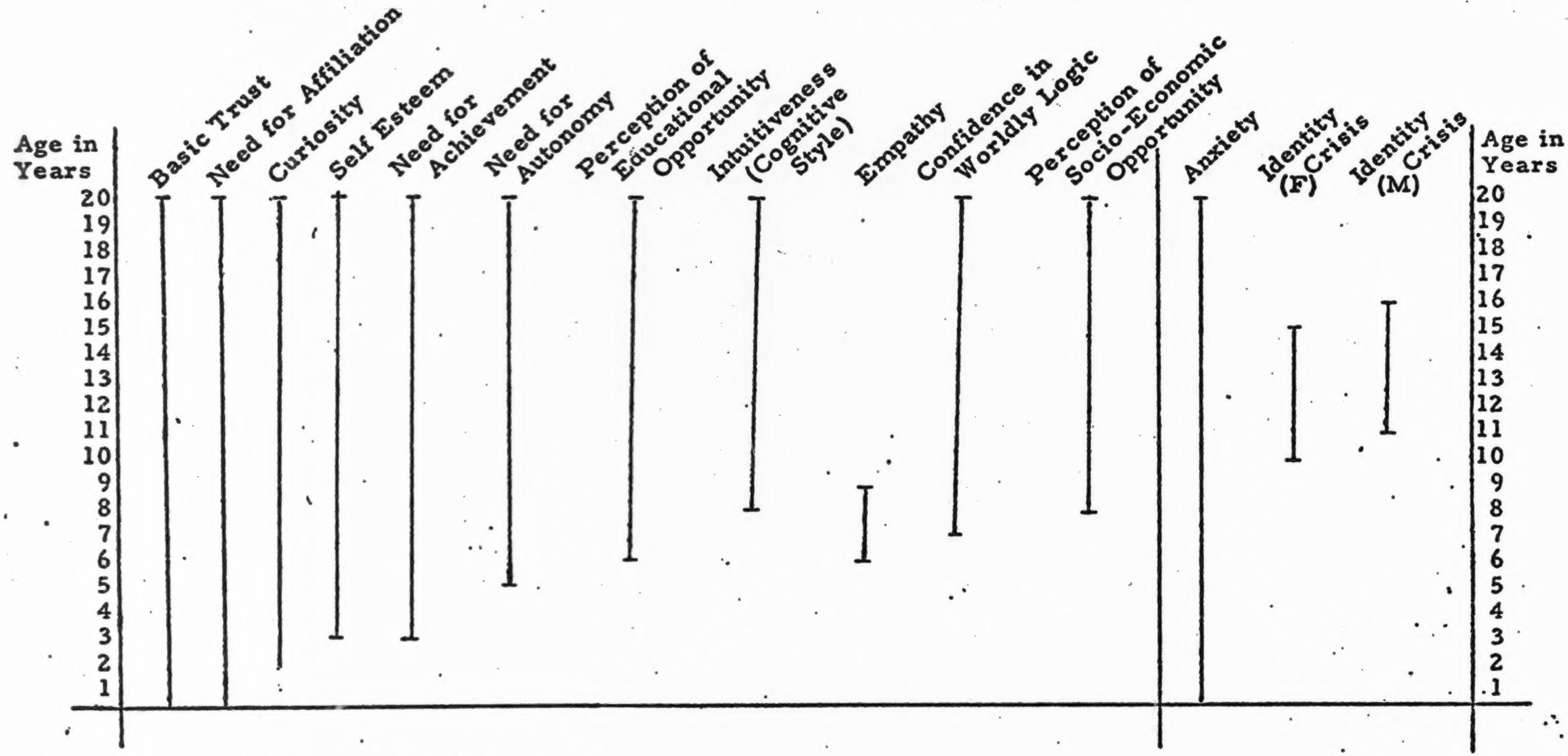
---

*Stanford Achievement Test for Elementary and Secondary, Metropolitan Readiness for Kindergarten.

LEARNING CATALYSTS

A. **Definition:**

Learning catalysts are attitudes and personality traits which, if stimulated at certain stages of child development, will facilitate productive responses to a scholastic environment.



B. CRITERIA FOR INCLUSION:

Learning catalysts must satisfy at least one of the following four conditions:

1. Motivate the student to take risks in areas of uncertainty;
2. Accelerate the student's socio-emotional development;
3. Sensitize the student to the learning cues of the classroom;
4. Expedite the student's "learning to learn" (heuristics).

CHART IV

INSTRUCTIONAL PROCESS OUTPUTS

MODEL OUTPUT VARIABLES	STANDARDIZED TEST MEASURES	TEST GRADE	TESTING TIME (MIN.)	MAJOR AREAS MEASURED
ACHIEVEMENTS		STANDARD ACHIEVEMENT TESTS		
1. Reading	Metropolitan Readiness	K-1	60	Reading readiness and number readiness
2. Language				
3. Mathematics	Stanford Achievement			
4. Science	- Elementary Levels	1-9	127-255	Reading, arithmetic, language, science, social studies, work-study skills
5. Social Studies				
6. Mechanical				
	- High School Level	9-12	282	Reading, mathematics, language, science, social studies, study skills
ATTITUDES AND PERSONALITY TRAITS		PERSONALITY, ATTITUDE AND INTEREST INVENTORIES		
1. Basic Trust				
2. Curiosity	Kuder Preference Record			
3. Self-Esteem	- Vocational	9-12	40-50	General vocational interest areas
4. Need-Achievement	- Personal	9-12	40-50	Types of social relations
5. Perception of Educational Opportunity	- Occupational	9-12	20-30	Scores for occupations
6. Empathy	Strong Vocational Interest Blank	11-12	40	Scores for occupations, general vocational areas, and special areas
7. Confidence in a Logical World				
8. Perception of Socio-Economic Opportunity	California Test of Personality	K-12	40-60	Personality, attitudes
9. Anxiety	SRA Inventories	4-12	30	
10. Need-Autonomy	Thematic Apperception Test	K-12	100	
11. Cognitive Style	Rosenzweig Picture.-Frustration Study	K-12	15	
12. Need-Affiliation				

CHART V

Schematic representations of the model logic are given in Charts VI and VII. In the first chart, student characteristics, operating conditions, and curriculum descriptions for pre- and post-Title I school environments are compared, related to the appropriate learning catalysts, and evaluated for their ultimate impact. In the second chart changes in learning catalysts are used to modify the historic or base-line achievement gains mentioned above. In both charts, Title I Projects have been subdivided into a "curriculum" category, for all subject matter related programs, and an "operating conditions" category, for all service related activities. Differences in student characteristics are determined by comparing the historic student populations with the Title I target group.

A more detailed example of how a changed learning catalyst can affect scholastic achievement is presented in Chart VIII. If the catalyst called EMPATHY (the ability to take another person's point of view) is stimulated between the ages of six and nine, the corresponding effects on three appropriate achievements (Mathematics, Social Studies, and Language) are computed from the empirically set relationships. The choice of appropriate achievements is made from both qualitative and quantitative research results, just as the choice of the appropriate catalysts affected by environmental changes is derived. These choices, and the relative weights associated with them, are subject to user judgment and modification. They also imply needed research areas and, since they are flexible, can be adjusted at any time with the discovery of more precise empirical results.

The last chart (number IX) identifies the required input categories for the operation of the Instructional Process Submodel. There are four of these: Title I Project Descriptions, Title I Case Histories, Current School Data &Historic School Data, and Research, Theory, and User Judgment. Each is given with some exemplary data and the source from which the data is derived. Special attention has been paid to data availability and an attempt has been made to exploit to the fullest the most accessible data, and to avoid the problems of sensitive data collection.

To recapitulate, the problem for the Instructional Process Submodel is "How much will each Title I Project affect the achievements and

TYPICAL LOGIC

Δ DATA ⟶ Δ CATALYST

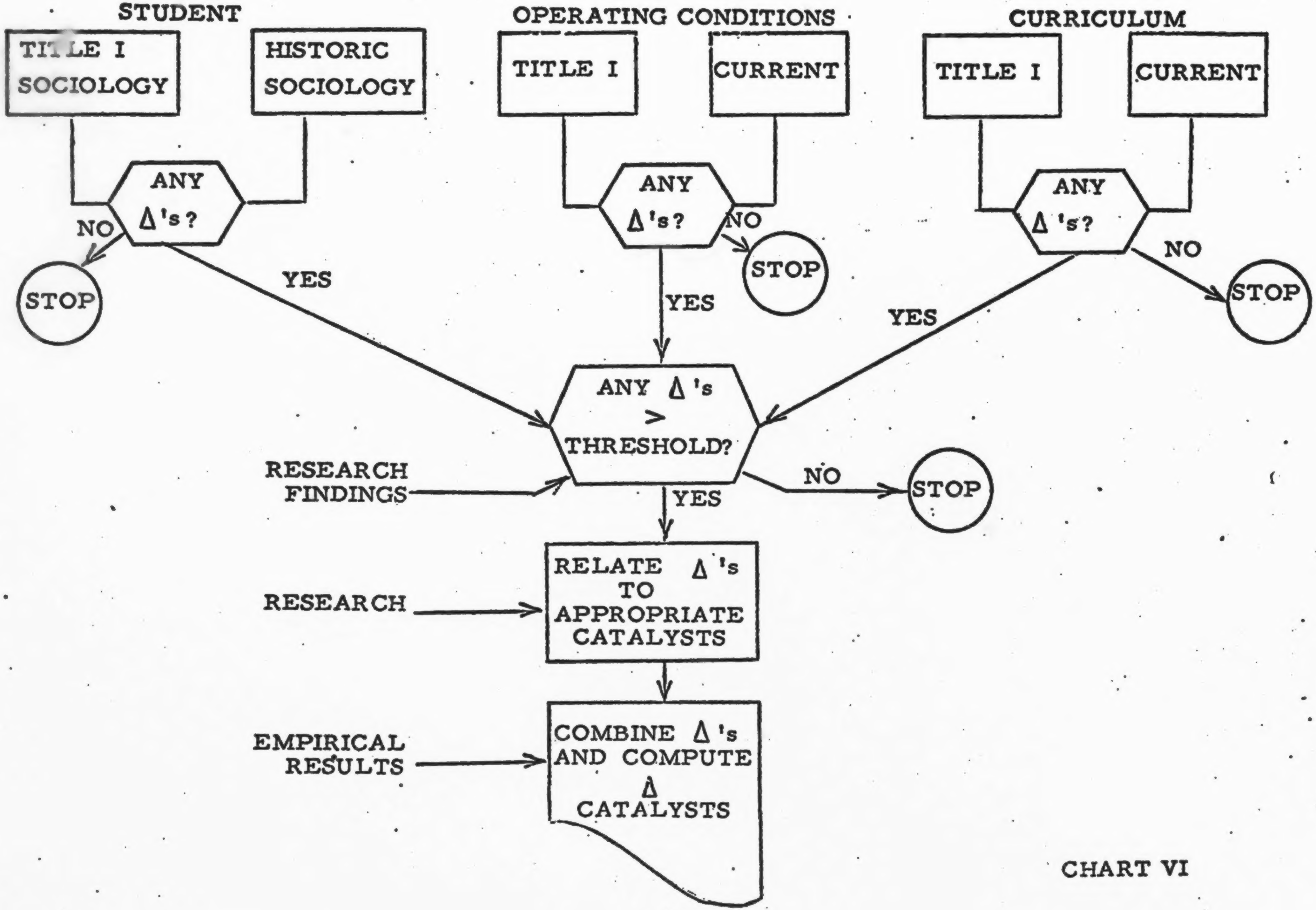

STUDENT
TITLE I SOCIOLOGY
HISTORIC SOCIOLOGY
ANY Δ's?
NO
STOP
YES
OPERATING CONDITIONS
TITLE I
CURRENT
ANY Δ's?
NO
STOP
YES
CURRICULUM
TITLE I
CURRENT
ANY Δ's?
NO
STOP
YES
ANY Δ's > THRESHOLD?
NO
STOP
YES
RESEARCH FINDINGS
RELATE Δ's TO APPROPRIATE CATALYSTS
RESEARCH
COMBINE Δ's AND COMPUTE Δ CATALYSTS
EMPIRICAL RESULTS

CHART VI

TYPICAL LOGIC

Δ CATALYST ⟶ Δ ACHIEVEMENT

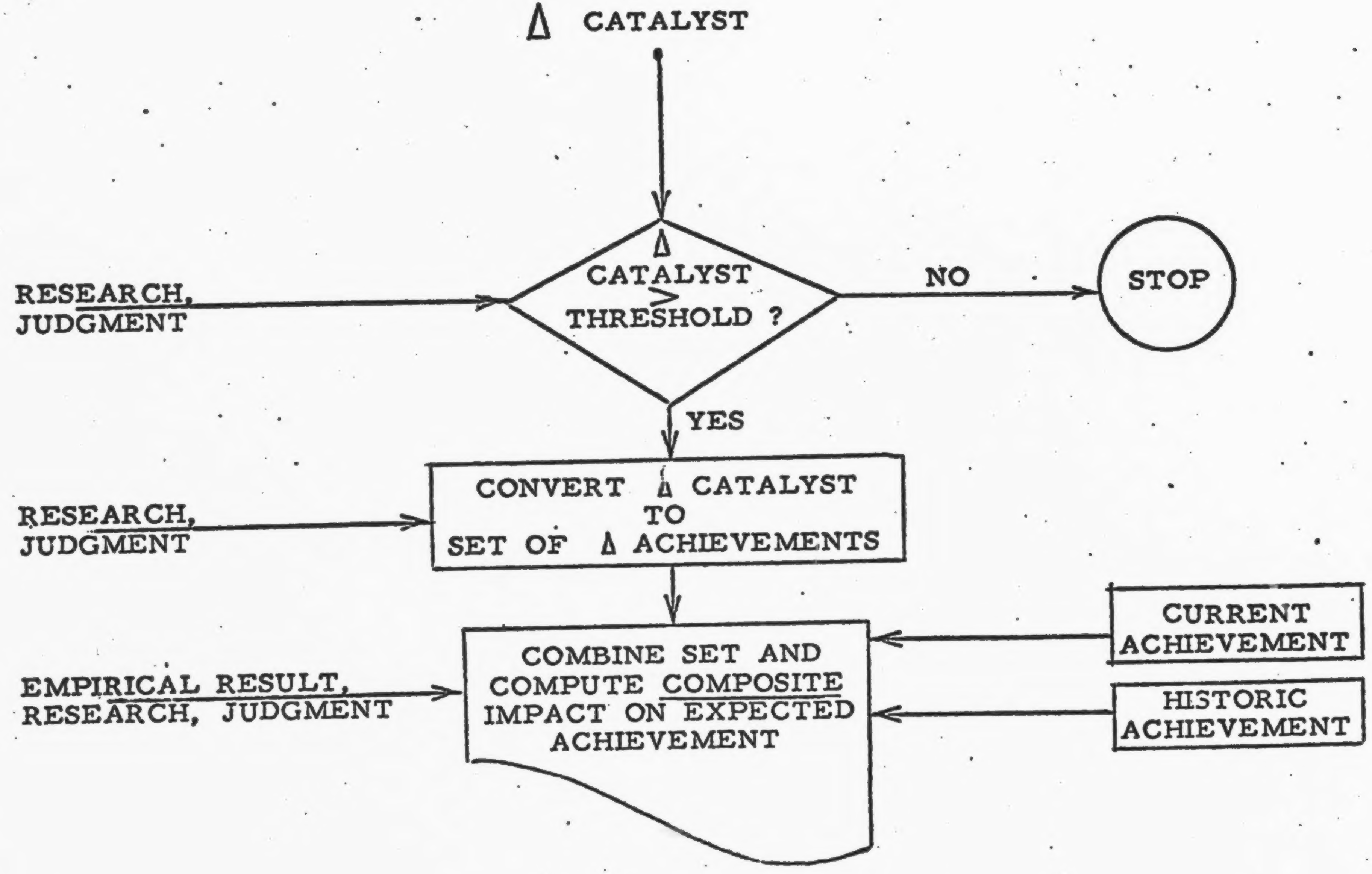

Δ CATALYST
RESEARCH, JUDGMENT
Δ CATALYST $\geq$ THRESHOLD ?
NO
STOP
YES
RESEARCH, JUDGMENT
CONVERT Δ CATALYST TO SET OF Δ ACHIEVEMENTS
EMPIRICAL RESULT, RESEARCH, JUDGMENT
COMBINE SET AND COMPUTE COMPOSITE IMPACT ON EXPECTED ACHIEVEMENT
CURRENT ACHIEVEMENT
HISTORIC ACHIEVEMENT

CHART VII

EFFECT OF A CHANGED LEARNING CATALYST ON ACHIEVMENT

— EMPATHY —

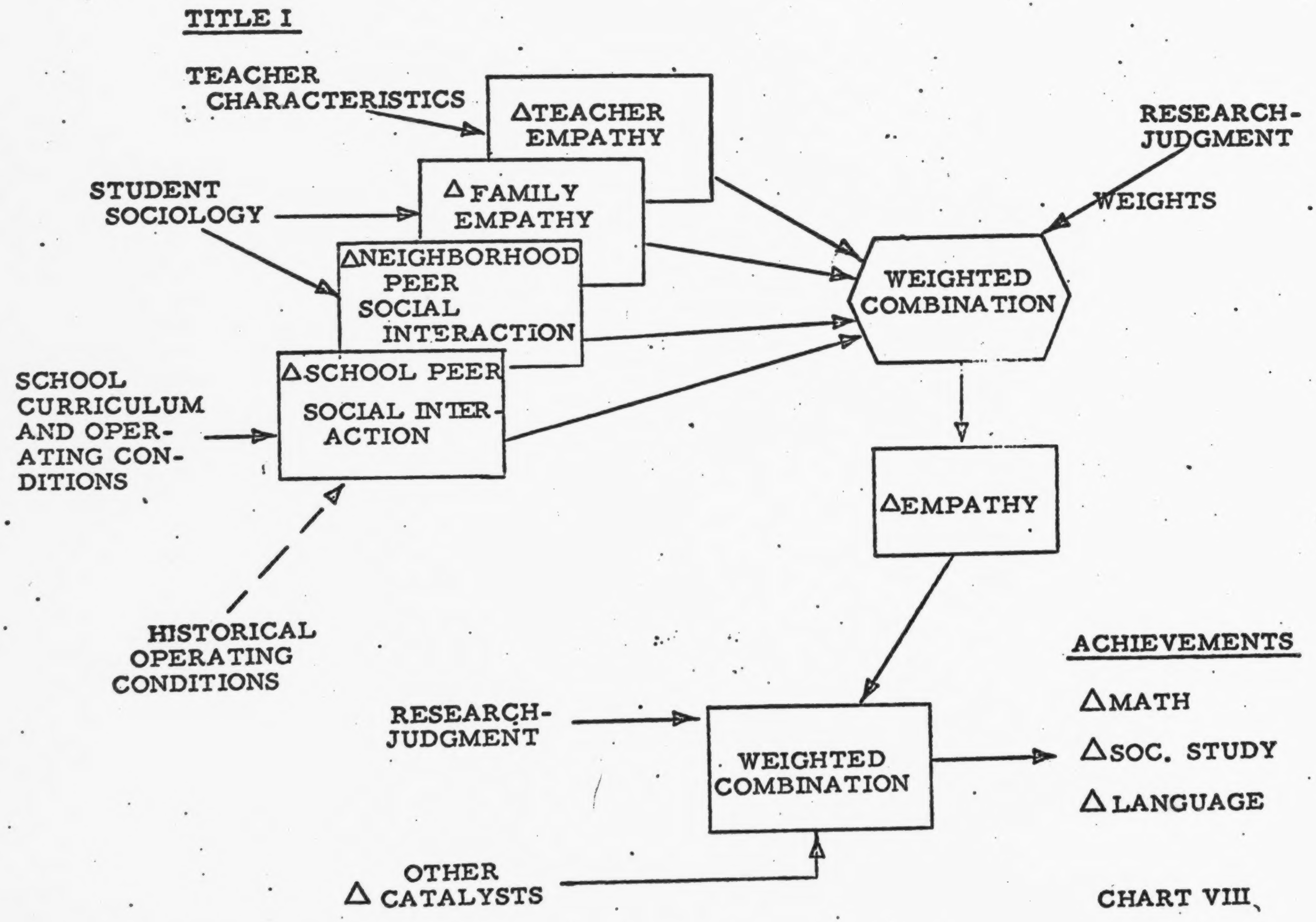

TITLE I
TEACHER CHARACTERISTICS
ΔTEACHER EMPATHY
STUDENT SOCIOLOGY
Δ FAMILY EMPATHY
ΔNEIGHBORHOOD PEER SOCIAL INTERACTION
SCHOOL CURRICULUM AND OPERATING CONDITIONS
ΔSCHOOL PEER SOCIAL INTERACTION
HISTORICAL OPERATING CONDITIONS
RESEARCH-JUDGMENT
WEIGHTS
WEIGHTED COMBINATION
ΔEMPATHY
RESEARCH-JUDGMENT
WEIGHTED COMBINATION
Δ OTHER CATALYSTS
ACHIEVEMENTS
ΔMATH
ΔSOC. STUDY
Δ LANGUAGE

CHART VIII

INSTRUCTIONAL PROCESS INPUTS

INPUT CATEGORY	DATA EXAMPLES	SOURCE
1. TITLE I PROJECT DESCRIPTION	1(A) CURRICULAR CHANGES (e.g. TEXT, INSTRUCTIONAL TECHNIQUE, AUDIO-VISUALS, SUBJECT MATTER, WORK EXPERIENCE, etc.)	1. DATA BASE
	1(B) CHANGES IN OPERATING CONDITIONS (e.g. ADDITIONAL TEACHING PERSONNEL, GUIDANCE AND COUNSELING, FREE LUNCH, EXTRA-CURRICULAR ENRICHMENT EXPERIENCES, etc.)	
2. TITLE I CASE HISTORY	2(A) PREVIOUS ACHIEVEMENT GAINS BY CURRICULUM NODE AND STUDENT TYPE	2. DATA BASE
	2(B) PREVIOUS CURRICULUM AND OPERATING CONDITIONS	
3. CURRENT AND HISTORICAL SCHOOL DATA	3(A) SOCIOLOGY OF (TARGET POPULATION (e.g. RACE, FAMILY INCOME, ORGANIZATION, SIBLING, BIRTH ORDER, NEIGHBORHOOD COMPOSITION, etc.)	3(A) DATA BASE
	3(B) ACHIEVEMENT LEVELS BY STUDENT TYPE, CURRICULUM NODE	3(B) SCHOOL SUBMODEL
4. RESEARCH, USER JUDGMENT	4(A) WEIGHTED CORRELATIONS BETWEEN CHANGES IN ENVIRONMENT AND CHANGES IN LEARNING CATALYSTS	4. DATA BASE
	4(B) WEIGHTED CORRELATIONS BETWEEN CHANGES IN CATALYSTS AND CHANGES IN SCHOLASTIC ACHIEVEMENT	

CHART IX

attitudes of the target population?" The Instructional Process defines a set of learning catalysts which must be stimulated before any accelerated learning can take place. Title I projects change the curriculum, or the operating conditions, or the student population, or combinations of these, and these changes activate the learning catalysts. If the catalysts are increased above a given threshold, then they will in turn affect scholastic achievements. These changes in scholastic achievements represent the impact of the Title I Project on the student population.

Working Paper
Does Not Reflect
Official Policy of
The Office of Education

NATIONAL CENTER FOR EDUCATIONAL STATISTICS
Division of Operations Analysis

A COST-EFFECTIVENESS MODEL FOR THE ANALYSIS OF TITLE I ESEA PROJECT PROPOSALS

PART IV

THE COMMUNITY SUBMODEL

Prepared for the Division of Operations Analysis

by

Abt Associates, Inc.
Under Contract No. OEC 1-6-001681-1681

Technical Note
Number 17
December 9, 1966

OFFICE OF EDUCATION/U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

NATIONAL CENTER FOR EDUCATIONAL STATISTICS
Alexander M. Mood, Assistant Commissioner

DIVISION OF OPERATIONS ANALYSIS
David S. Stoller, Director

PREFACE

This Technical Note is the fourth part of a seven-part issue which describes a Cost-Effectiveness Model for the analysis of Title I ESEA Project Proposals. The seven parts are:

TN-14 Part I - An Overview of the Cost-Effectiveness Model and Submodels for the Evaluation of Title I ESEA Proposals

TN-15 Part II - The School Submodel

TN-16 Part III- The Instructional Process Submodel

TN-17 Part IV - The Community Submodel

TN-18 Part V - The Cost Submodel

TN-19 Part VI - The Effectiveness Submodel

TN-20 Part VII- The Simulation

The model was developed by Abt Associates, of Cambridge, Massachusetts, for the Division of Operations Analysis, National Center for Educational Statistics, under contract number OEC 1-6-001681-1681.

THE COMMUNITY SUBMODEL

The Community Submodel as it now stands is a set of independently operating subroutines which convert Data Base information, Instructional Process Submodel attitudinal and School Submodel achievement data into indicators of selected community factors in which a change is expected or desired (See Chart C-1). These outputs are selected on the basis of presumed interest to Title I evaluators. Present and past values for these outputs for a particular community will be already known; the Title I evaluator's concern is the predicted future values which incorporate both Title I inputs, tracing their community effects, and extrapolated community trends contributing to a change in these indicators relatively independent of Title I.

For long-range planning it would also be desirable to cycle these outputs back through the community to see how they affect the School and the Instructional Process (presumably a sort of 'snowball' process). A complete full-scale working model of the community would perform all three desired functions. However, data gaps and the absence of systematic research findings on the majority of the many components of a complete Community Model leave too much to speculation.* The current Community Submodel represents the alternative of higher reliability on a somewhat more limited scale. The two criteria for selection were relative reliability, i.e., areas in which extant research has at least pointed the direction of relationships, and interest for immediate Title I evaluation needs.

Each of the seven submodel outputs, with the exception of the composite community involvement indicator, has a separate subroutine logic, although they share many of the same Instructional Process inputs. The logics produce target population community effects, with and without Title I changes in Instructional Process variables used.

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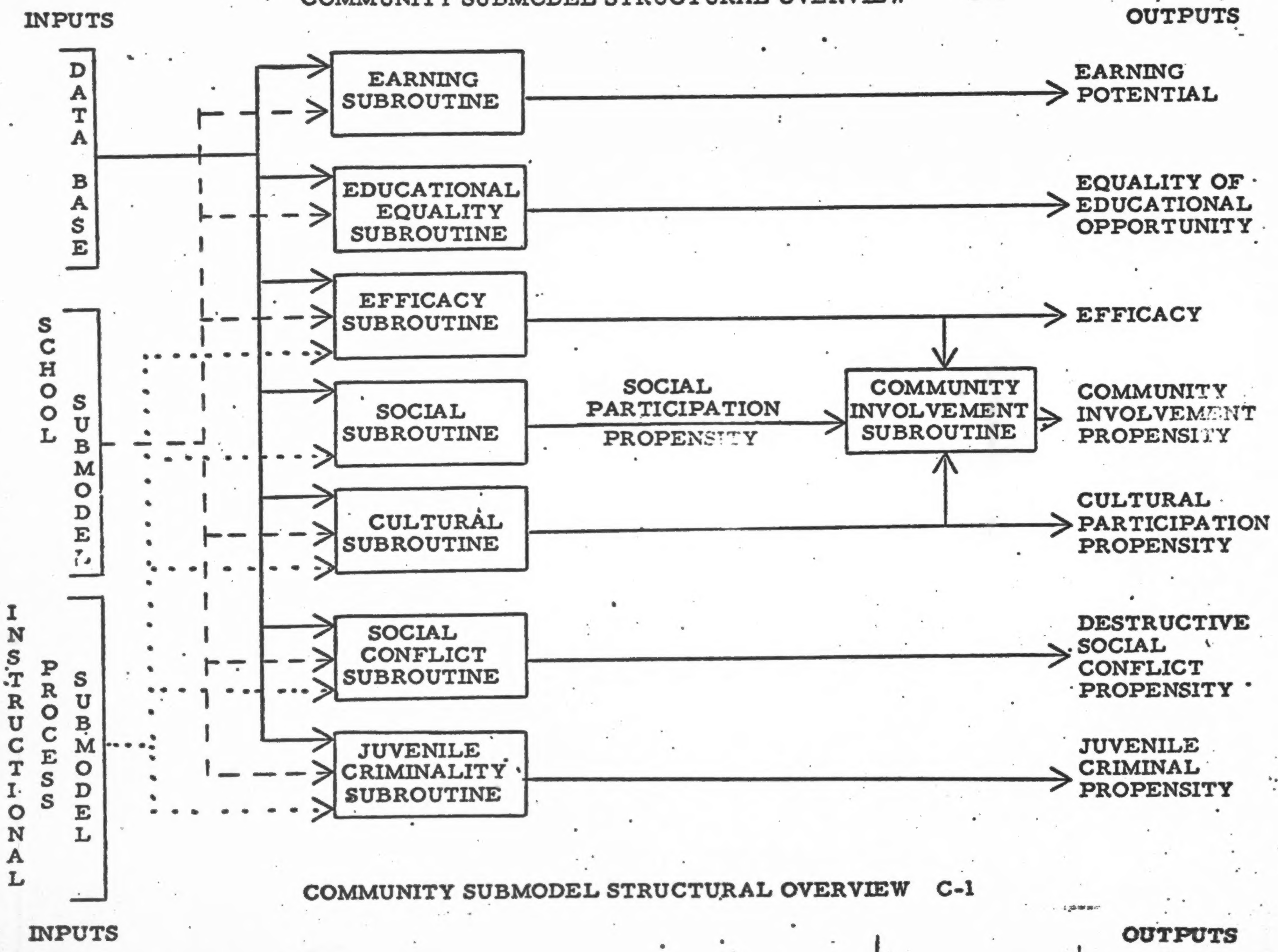
*This finding is based on a full-scale theoretical modeling effort carried out earlier in the history of this contract and reported in the Appendix. The results of this feasibility study are nevertheless generally favorable, given the possibility of a larger scale effort with an associated research program.

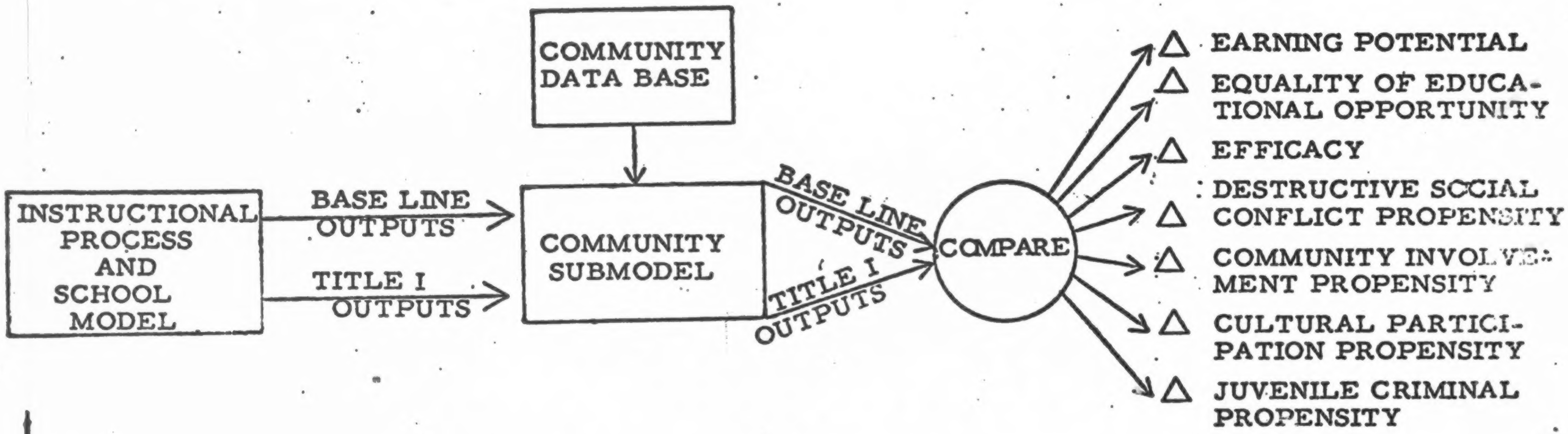
COMMUNITY SUBMODEL STRUCTURAL OVERVIEW C-1


INPUTS
OUTPUTS
DATA BASE
SCHOOL SUBMODEL
INSTRUCTIONAL PROCESS SUBMODEL
EARNING SUBROUTINE
EDUCATIONAL EQUALITY SUBROUTINE
EFFICACY SUBROUTINE
SOCIAL SUBROUTINE
CULTURAL SUBROUTINE
SOCIAL CONFLICT SUBROUTINE
JUVENILE CRIMINALITY SUBROUTINE
SOCIAL PARTICIPATION PROPENSITY
COMMUNITY INVOLVEMENT SUBROUTINE
EARNING POTENTIAL
EQUALITY OF EDUCATIONAL OPPORTUNITY
EFFICACY
COMMUNITY INVOLVEMENT PROPENSITY
CULTURAL PARTICIPATION PROPENSITY
DESTRUCTIVE SOCIAL CONFLICT PROPENSITY
JUVENILE CRIMINAL PROPENSITY
INPUTS
OUTPUTS

COMMUNITY SUBMODEL STRUCTURAL OVERVIEW C-1

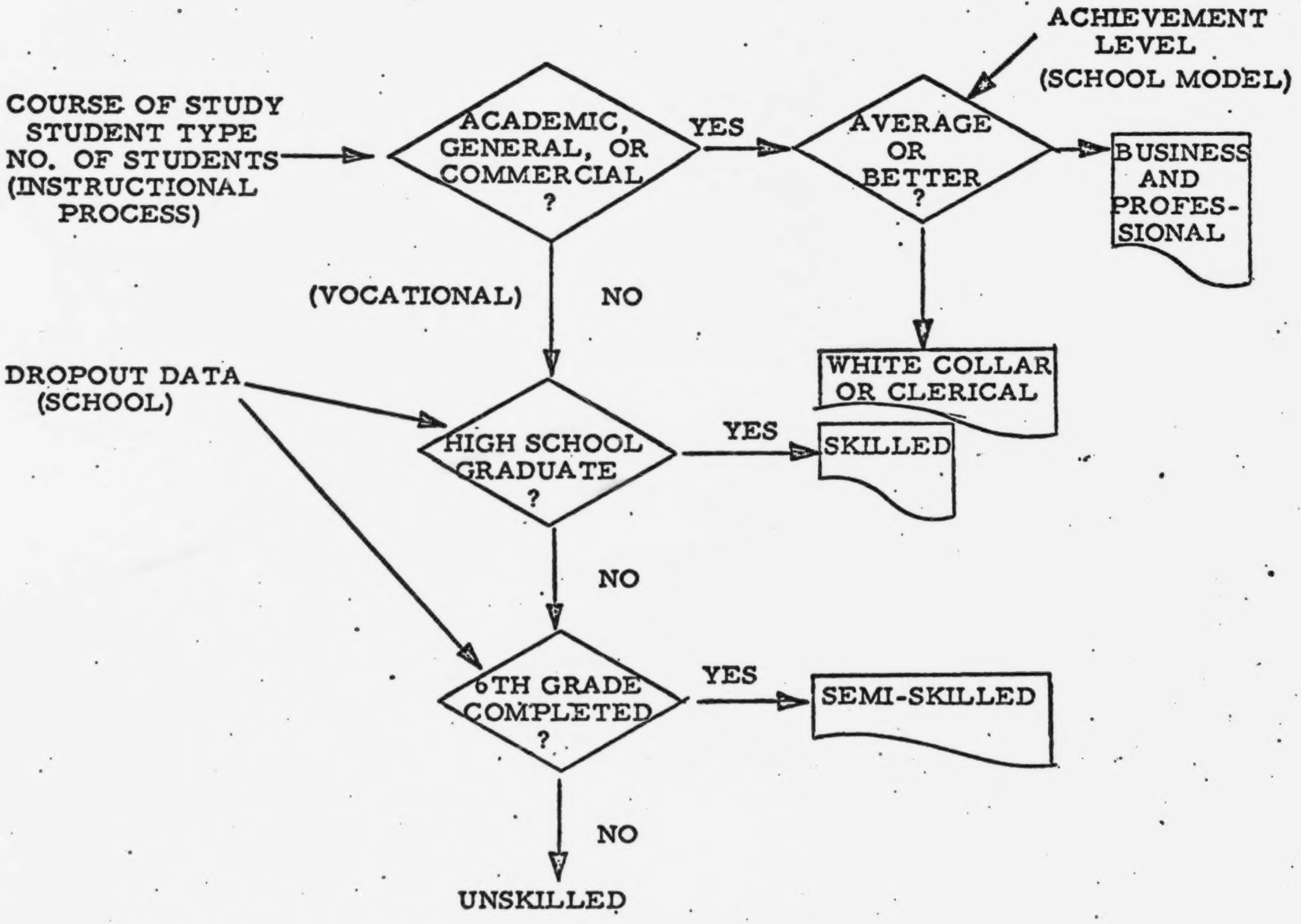
COMMUNITY SUBMODEL DYNAMIC OVERVIEW

C-2

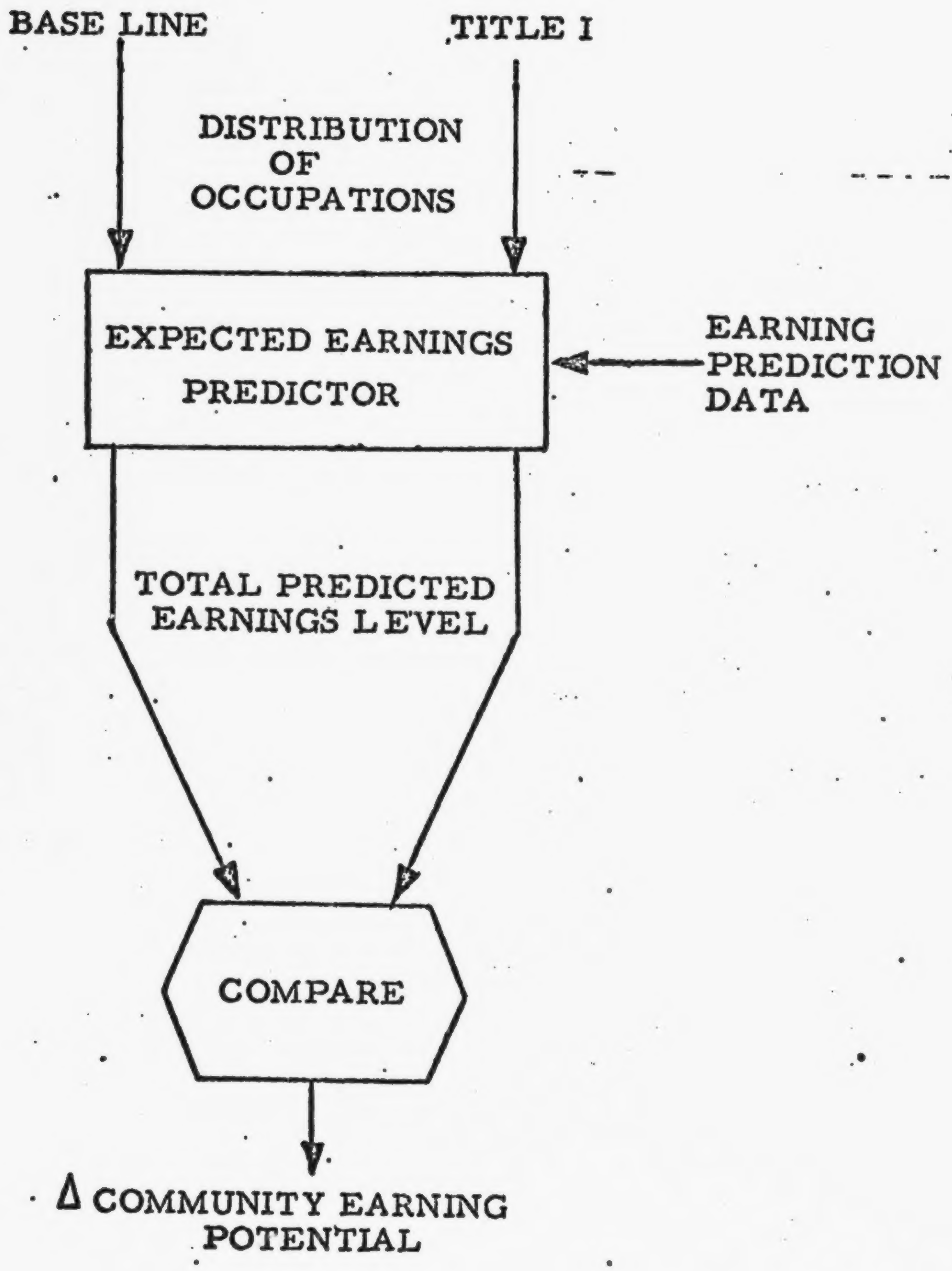

INSTRUCTIONAL PROCESS AND SCHOOL MODEL
BASE LINE OUTPUTS
TITLE I OUTPUTS
COMMUNITY DATA BASE
COMMUNITY SUBMODEL
BASE LINE OUTPUTS
TITLE I OUTPUTS
COMPARE
△ EARNING POTENTIAL
△ EQUALITY OF EDUCATIONAL OPPORTUNITY
△ EFFICACY
△ DESTRUCTIVE SOCIAL CONFLICT PROPENSITY
△ COMMUNITY INVOLVEMENT PROPENSITY
△ CULTURAL PARTICIPATION PROPENSITY
△ JUVENILE CRIMINAL PROPENSITY

The future value prediction for Community Submodel outputs, and thus for community changes (Δ's) resultant of Title I inputs, are derived from the process common to all of the simulation. (See Chart C-2 for the dynamics). The main implication of the first Base Line Run for the Community Subroutine logics is the establishment of threshold values; this is the 'tuning' of the submodel. Once these threshold values are established, the Model is run with the projected Title I program inputs. Resultant changes in Instructional Process achievements and attitudes are passed on to the Community subroutines where they are combined in various ways and tested for threshold value. The result is a set of projected propensities for community effects on the part of the target population. By subtracting the Base Line Run outputs from the 'future' outputs we get the changes resultant from the particular Title I program being evaluated. These effects are independent of other changes due to extensions of current community trends or exogenous inputs other than Title I. Hence the outputs are in terms of tendencies rather than predictions of specific behavior.

EARNING POTENTIAL SUBROUTINE C-3


ACHIEVEMENT LEVEL (SCHOOL MODEL)
COURSE OF STUDY
STUDENT TYPE
NO. OF STUDENTS
(INSTRUCTIONAL PROCESS)
ACADEMIC, GENERAL, OR COMMERCIAL ?
YES
AVERAGE OR BETTER ?
BUSINESS AND PROFES- SIONAL
(VOCATIONAL)
NO
WHITE COLLAR OR CLERICAL
DROPOUT DATA (SCHOOL)
HIGH SCHOOL GRADUATE ?
YES
SKILLED
NO
6TH GRADE COMPLETED ?
YES
SEMI-SKILLED
NO
UNSKILLED

TRANSLATION OF OCCUPATION TO INCOME C-3 a

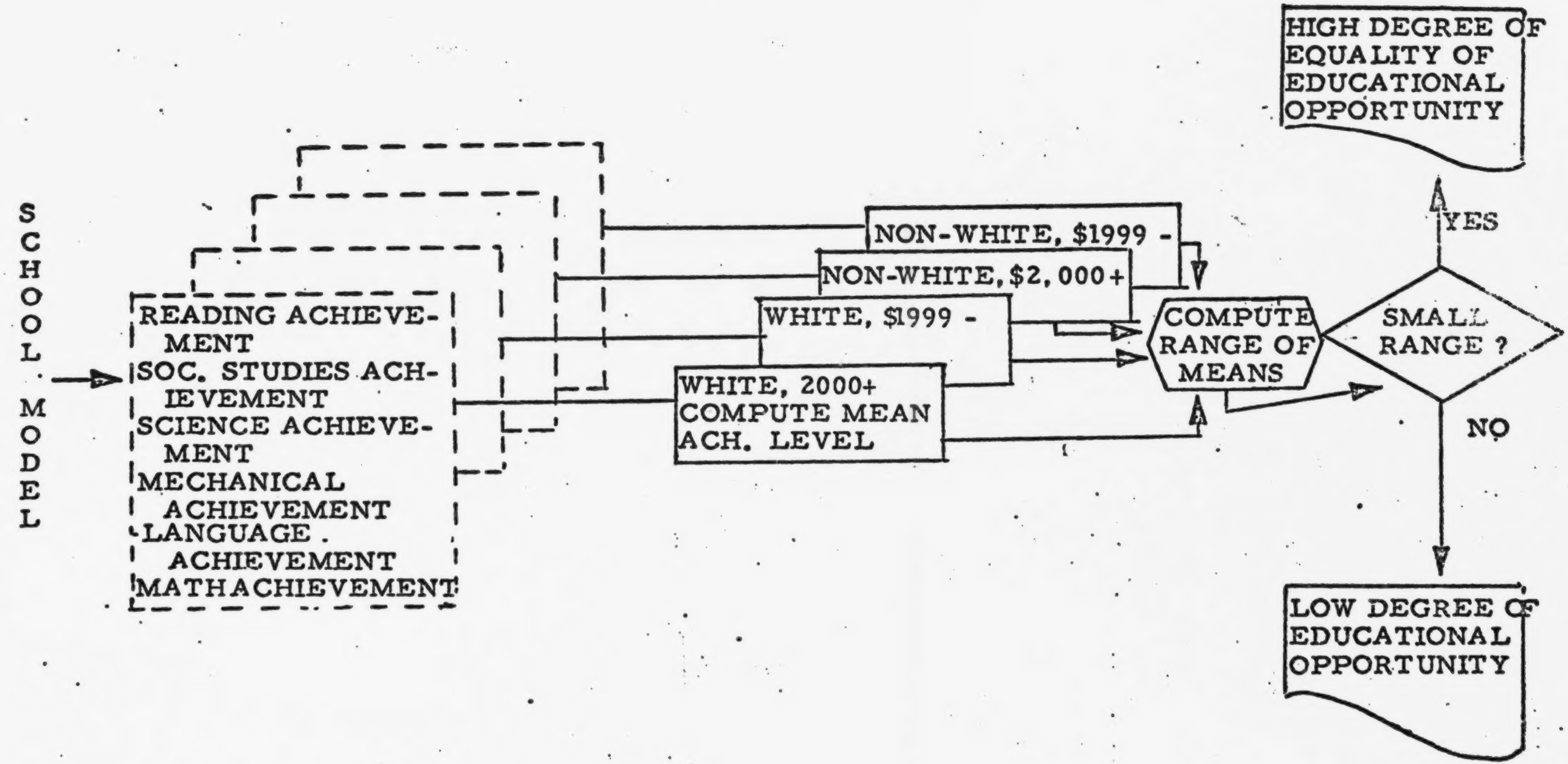

BASE LINE
TITLE I
DISTRIBUTION OF OCCUPATIONS
EXPECTED EARNINGS PREDICTOR
EARNING PREDICTION DATA
TOTAL PREDICTED EARNINGS LEVEL
COMPARE
Δ COMMUNITY EARNING POTENTIAL

EARNING POTENTIAL SUBROUTINE

The Earning Potential Subroutine is a simple but reliable procedure for quantitatively assessing the impact of any proposed Title I program upon the ability of the target population to earn a living. Its operation is straightforward: predict on the basis of course of study (Academic, Commercial, General, Vocational), achievement level in school, and graduation/dropout statistics, that occupational class (Business/Professional, White Collar/Clerical, Skilled, Semi-Skilled, Unskilled) in which each of the distinguishable student groups within the model will earn a living (Fig. C-3). From this prediction, and from correlation study data relating occupational class with expected lifetime earnings, we can compute a rough figure for total predicted earnings of the model population. Comparing total predicted earnings figures from the base line run and the run with Title I programs, we can get an index of change in Community Earning Potential, i.e., large increase, increase, no change, decrease, large decreases (Fig. C-3a).

In point of fact, the procedure described above is one part of a subroutine created for the current project which models the economic life of a community in greater detail. While this subroutine is at a level of detail too high for the purposes of the current overall model, a description is included of it as Appendix A to indicate the direction which might profitably be taken should a decison to expand the scope of the Community Submodel be taken.

EQUALITY OF EDUCATIONAL OPPORTUNITY SUBROUTINE C-4


SCHOOL MODEL
READING ACHIEVEMENT
SOC. STUDIES ACHIEVEMENT
SCIENCE ACHIEVEMENT
MECHANICAL ACHIEVEMENT
LANGUAGE . ACHIEVEMENT
MATHACHIEVEMENT
NON-WHITE, $1999 -
NON-WHITE, $2,000+
WHITE, $1999 -
WHITE, 2000+ COMPUTE MEAN ACH. LEVEL
COMPUTE RANGE OF MEANS
SMALL RANGE ?
YES
NO
HIGH DEGREE OF EQUALITY OF EDUCATIONAL OPPORTUNITY
LOW DEGREE OF EDUCATIONAL OPPORTUNITY

EQUALITY OF EDUCATIONAL OPPORTUNITY

The primary aim of Title I is to equalize educational opportunities throughout the country. Since "opportunities" themselves are difficult, if not impossible to measure directly, this subroutine utilizes Coleman's[1] logic in deriving an indicator of the equality of educational opportunity. His method was to correlate achievement scores with social origins. Where equality of educational opportunity was high, there would be no correlation with social origin.

This subroutine computes a mean achievement score for each of the four population groups, based on data from the School Model. It then prints out a distribution of means and computes the range. If the range is small, a high degree of equality of educational opportunity is indicated, and the opposite is shown by a large range. Any Title I program which succeeds in raising the achievement level of any of the population groups whose mean is low will reduce the inequality of educational opportunity.

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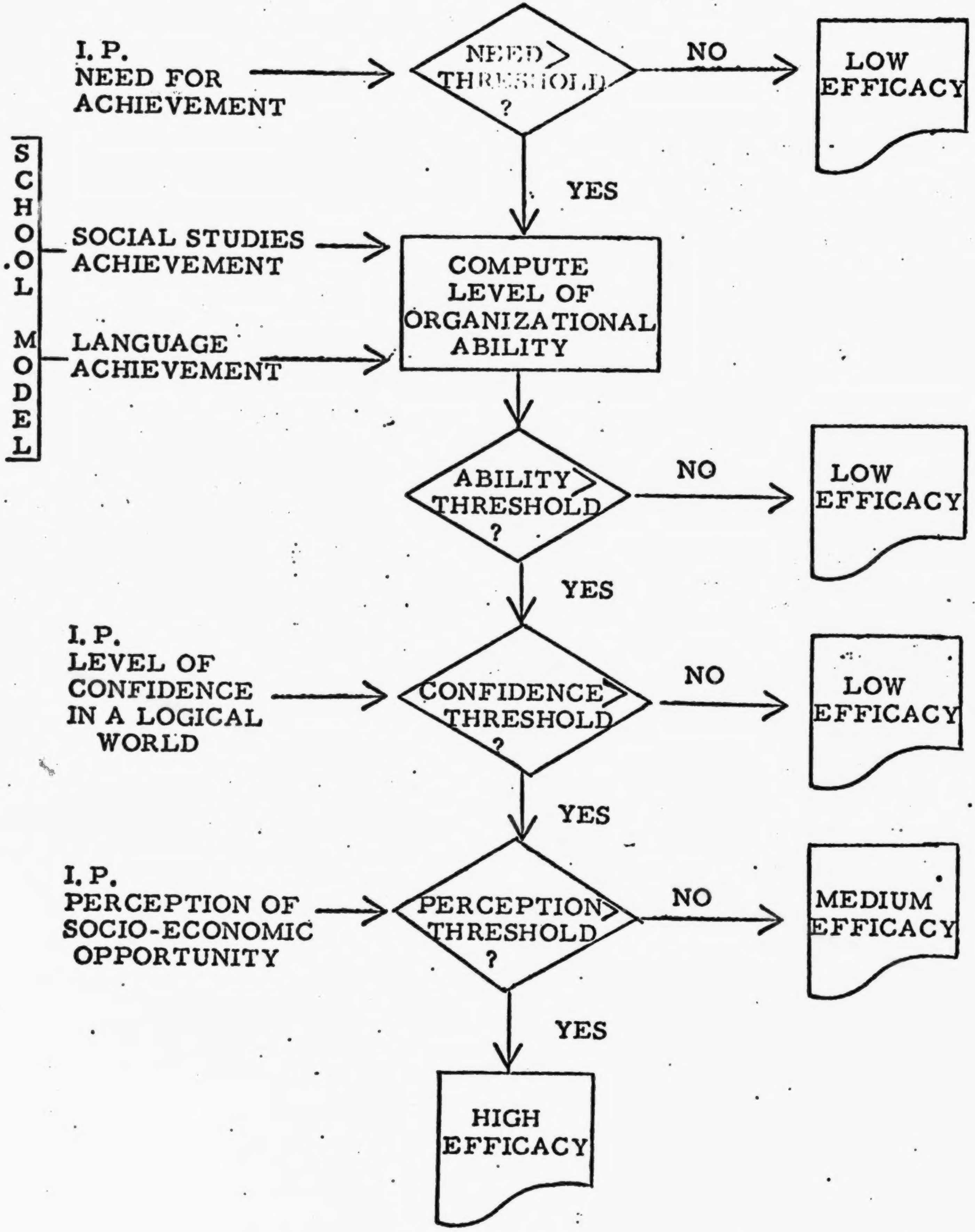
[1] James Coleman, "Equal Schools or Equal Students", The Public Interest, Vol. 4, Summer, 1966.

EFFICACY SUBROUTINE C-5

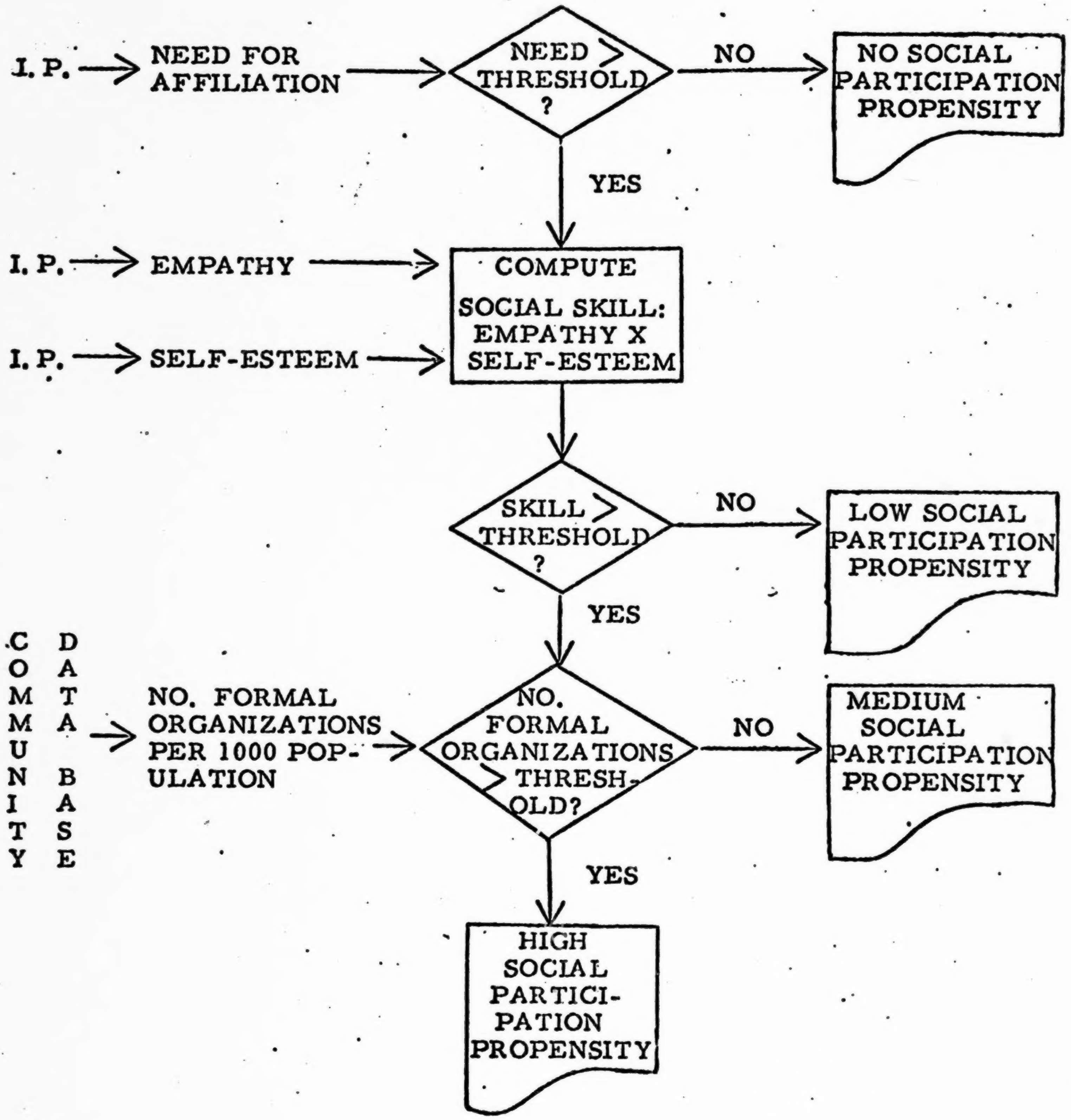

I. P.
NEED FOR ACHIEVEMENT
NEED > THRESHOLD ?
NO
LOW EFFICACY
YES
SCHOOL MODEL
SOCIAL STUDIES ACHIEVEMENT
LANGUAGE ACHIEVEMENT
COMPUTE LEVEL OF ORGANIZATIONAL ABILITY
ABILITY > THRESHOLD ?
NO
LOW EFFICACY
YES
I. P.
LEVEL OF CONFIDENCE IN A LOGICAL WORLD
CONFIDENCE > THRESHOLD ?
NO
LOW EFFICACY
YES
I. P.
PERCEPTION OF SOCIO-ECONOMIC OPPORTUNITY
PERCEPTION > THRESHOLD ?
NO
MEDIUM EFFICACY
YES
HIGH EFFICACY

EFFICACY SUBROUTINE

The function of the efficacy subroutine is to produce an indicator of a population group's power over its environment and hence its ability to bring about a desired result. It implies both the willingness and ability to effect change, and a belief that ordered change and improvement are possible. In evaluating the effectiveness of a Title I program, it is worthwhile to examine changes in a community's likelihood for undertaking such activities as self-help projects. This routine translates attitude and achievement indices of the target population, (outputs of the instructional process and school models) into a series of decision thresholds. Each threshold acts as a screen to filter off those population groups who do not meet minimum success criteria at each level of decision.

For example, a Title I sponsored work-study program in which students could apply newly acquired skills to remunerative work might increase their need achievement level. If this were greater than the established threshold, one would then examine their organizational ability. For the purposes of the model, social studies achievement and language skills, determined by standardized test scores and aggregated by population type are used to yield an index of organizational ability. Such a work-study program could enhance social studies achievement but might not affect communication skills. If the population group did not meet the minimum requirement for organizational ability their efficacy index would be low. If their organizational ability were adequate, two attitudinal variables would be considered: the population group's level of confidence in a logical world and their perception of their socio-economic opportunity. Unless there exists a high level of confidence in a rational, ordered world where, given the proper channels, one can effect change, a population group would not attempt a community action project. Both of these attitudes might be enhanced by a work-study program by acquainting the students with a real-world example of cause and effect in the work situation and be increasing their socio-economic level. The population groups who successfully pass through the four decision thresholds and have the prerequisite organizational ability will receive a high efficacy rating.

SOCIAL PARTICIPATION PROPENSITY C-6


I. P.
NEED FOR AFFILIATION
NEED > THRESHOLD ?
NO
NO SOCIAL PARTICIPATION PROPENSITY
YES
I. P.
EMPATHY
I. P.
SELF-ESTEEM
COMPUTE SOCIAL SKILL: EMPATHY X SELF-ESTEEM
SKILL > THRESHOLD ?
NO
LOW SOCIAL PARTICIPATION PROPENSITY
YES
COMMUNITY DATA BASE
NO. FORMAL ORGANIZATIONS PER 1000 POPULATION
NO. FORMAL ORGANIZATIONS > THRESHOLD?
NO
MEDIUM SOCIAL PARTICIPATION PROPENSITY
YES
HIGH SOCIAL PARTICIPATION PROPENSITY

SOCIAL PARTICIPATION PROPENSITY SUBROUTINE

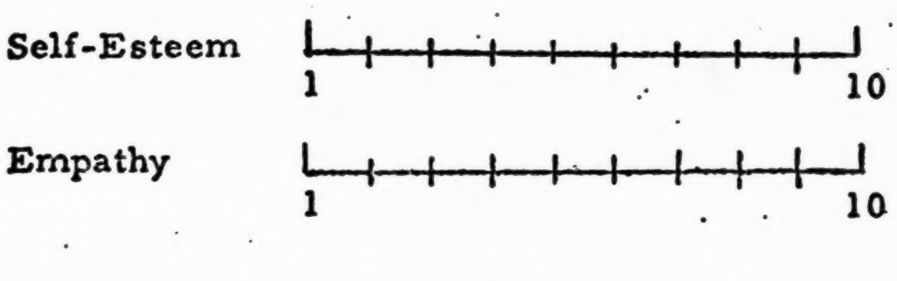
For present model purposes the function of this subroutine is the production of a social participation propensity output which is defined as formal organizational participation (voluntary associations like civic groups, fraternal orders, as well as churches, political parties, labor and commerce associations, etc.) The importance of this factor to community involvement, especially as a sort of marker of the traditional American cultural pattern, has been recognized since it was first noted in DeToqueville's Democracy in America. We therefore expect it to contribute to the expected effect of Title I on the community.

Within the subroutine certain attitudinal indices for the target population are input from the Instructional Process Submodel; they are combined and tested for threshold value to produce social participation propensity. A positive social participation propensity value is 'multiplied' by the availability of formal organizations, a data base input.

Need for affiliation is a necessary but not sufficient input. This need is compared with the calibrated threshold need value. If it is greater than threshold, we have satisfied the need condition and move to the capability condition. Capability here is social skills sufficient to enable one to join formal organizations. Social skills equal interpersonal skills. An index of social skills is computed from Empathy and Self-Esteem attitudinal variables (inputs from IP). These two factors are both deemed necessary in some degree for successful social interaction; a high degree of both self-esteem and empathy is considered much more favorable than a high on one and low on the other.

Therefore the scale values are multiplied to insure that an extraordinarily high value on one does not compensate in the index for an extraordinarily low value on the other, as might occur were this an additive function.

Example:



Sample values:

$SE = 6$	$SE = 4$
$EM = 2$	$EM = 4$
'Fair'	'Good'

If additive:

$SE + EM =$ Social Skills Index
$6 + 2 = 8$
$4 + 4 = 8$ Can't distinguish

If multiplicative:

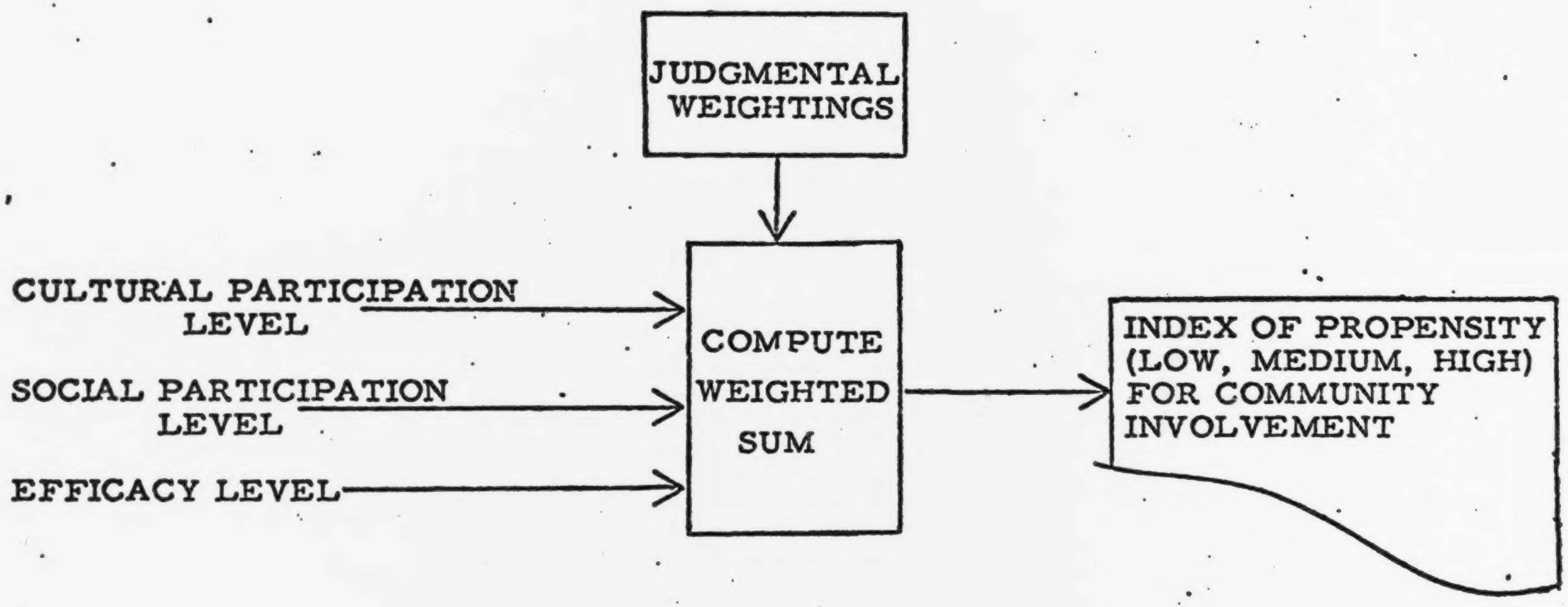
$SE \times EM =$ Social Skills Index
$6 \times 2 = 12$ 'Fair'
$4 \times 4 = 16$ 'Good'

Social skills index is then tested for threshold value. If the threshold is passed, the result is 'medium' social participation propensity. Propensity, however, also includes some measure of availability, in this case possible formal organizations per population. An increase in number of formal organizations extant (available) per population therefore results in high change in social participation propensity.

A Title I program involving field trips for cultural and educational development might be expected to raise Empathy directly, and indirectly increase Self-Esteem, thus contributing greatly to the Social Skills Index which multiplies the two. It is therefore a good example of how Title I can produce considerable effects in social participation propensity.

PROPENSITY FOR COMMUNITY INVOLVEMENT SUBROUTINE C-7

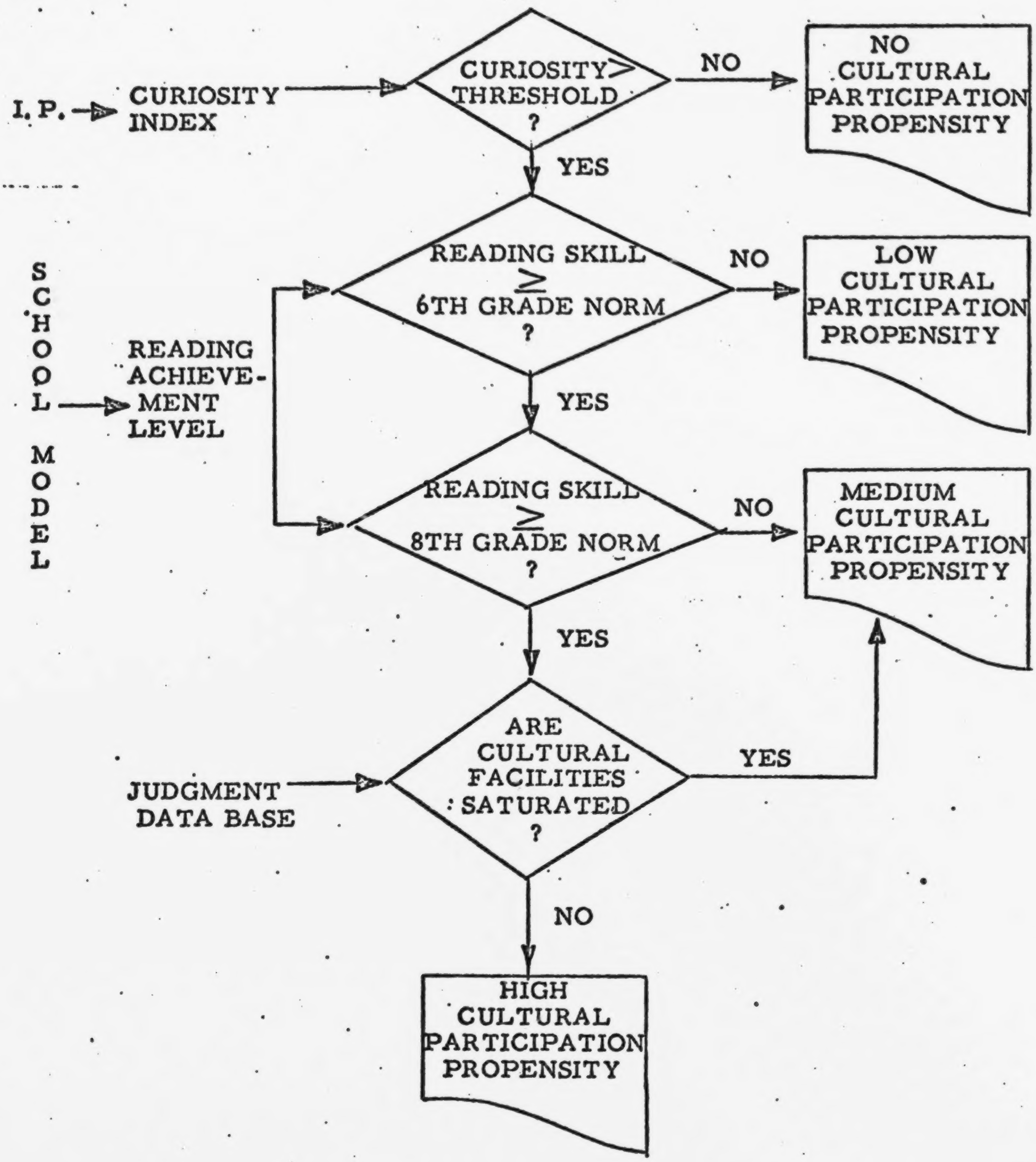
COMMUNITY


JUDGMENTAL WEIGHTINGS
CULTURAL PARTICIPATION LEVEL
SOCIAL PARTICIPATION LEVEL
EFFICACY LEVEL
COMPUTE WEIGHTED SUM
INDEX OF PROPENSITY (LOW, MEDIUM, HIGH) FOR COMMUNITY INVOLVEMENT

PROPENSITY FOR COMMUNITY INVOLVEMENT

One of the important factors in maintaining or achieving community cohesiveness is the level of involvement or vestment various population groups may have in the community. The propensity for community involvement is a combination of a group's propensity for cultural and social participation, as described above, and their desire and ability to act, or their efficacy rating. The indices derived from these three subroutines are weighted and summed to provide an index of community involvement.

CULTURAL PARTICIPATION SUBROUTINE C-8


I. P.
CURIOSITY INDEX
CURIOSITY ≥ THRESHOLD ?
NO
NO CULTURAL PARTICIPATION PROPENSITY
YES
SCHOOL MODEL
READING ACHIEVE-MENT LEVEL
READING SKILL ≥ 6TH GRADE NORM ?
NO
LOW CULTURAL PARTICIPATION PROPENSITY
YES
READING SKILL ≥ 8TH GRADE NORM ?
NO
MEDIUM CULTURAL PARTICIPATION PROPENSITY
YES
JUDGMENT DATA BASE
ARE CULTURAL FACILITIES SATURATED ?
YES
NO
HIGH CULTURAL PARTICIPATION PROPENSITY

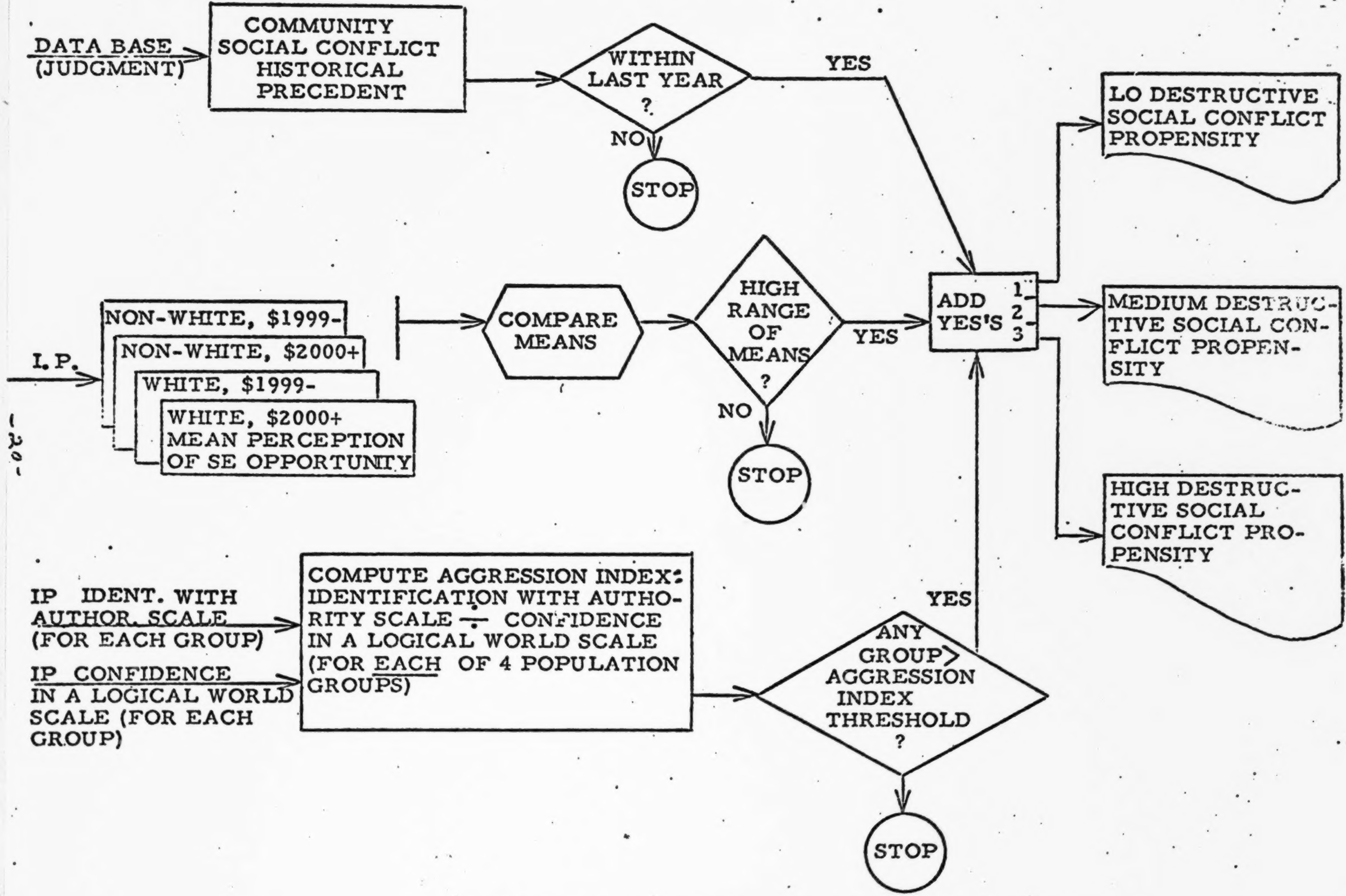
CULTURAL PARTICIPATION SUBROUTINE

Cultural participation propensity is defined in this model as a population group's tendency to acquire the values, beliefs and norms which their community has drawn from the nationally shared culture. This subroutine serves two purposes in the model. First, it provides a rough indication of the extent to which an exogenous Title I program may change the disparity between the culture of the target group and the remainder of the population. Second, when combined with social participation propensity and efficacy, this subroutine yields an indicator of community involvement.

The process for determining cultural participation propensity is a series of decision thresholds through which each target population passes, yielding an indicator of the level of participation. The theory underlying the routine is that, given a level of curiosity greater than an established threshold, a reading achievement of sixth grade level or better and adequate cultural facilities, a population group will have the tendency to share in the national culture. Reading achievement level is included because it is the best available indicator of the kinds of mass media a group may utilize. To the extent that curiosity, or "need-to-know" and reading achievement are increased, the depth and breadth of the target population's cultural awareness will also increase. If cultural facilities are not saturated, participation propensity is also increased.

For example, assuming an adequate curiosity threshold, let us consider the effects of a remedial reading program on non-whites of high school age with incomes of less than $2,000. If it does not succeed in increasing the reading skill of this population to sixth grade level, their propensity for cultural participation will be low and probably include only radio and television as available communication media. If this program is successful in upgrading reading achievement to this level, newspapers and magazines become possible sources of information. If reading achievement is at the eighth grade level, then the propensity for cultural participation will be high, provided adequate facilities are available. A judgmental input is required to determine whether current facilities are saturated. If the Title I program increases cultural facilities, a negative response at this decision threshold would yield a high propensity for cultural participation. It is possible for the subroutine to show that additional facilities may themselves attract new participants and hence enhance the cultural participation propensity rating for their population group.

SOCIAL CONFLICT SUBROUTINE


DATA BASE (JUDGMENT)
COMMUNITY SOCIAL CONFLICT HISTORICAL PRECEDENT
WITHIN LAST YEAR ?
YES
NO
STOP
I.P.
NON-WHITE, $1999-
NON-WHITE, $2000+
WHITE, $1999-
WHITE, $2000+ MEAN PERCEPTION OF SE OPPORTUNITY
COMPARE MEANS
HIGH RANGE OF MEANS ?
YES
NO
STOP
ADD YES'S
1
2
3
LO DESTRUCTIVE SOCIAL CONFLICT PROPENSITY
MEDIUM DESTRUCTIVE SOCIAL CONFLICT PROPENSITY
HIGH DESTRUCTIVE SOCIAL CONFLICT PROPENSITY
IP IDENT. WITH AUTHOR. SCALE (FOR EACH GROUP)
IP CONFIDENCE IN A LOGICAL WORLD SCALE (FOR EACH GROUP)
COMPUTE AGGRESSION INDEX: IDENTIFICATION WITH AUTHORITY SCALE ÷ CONFIDENCE IN A LOGICAL WORLD SCALE (FOR EACH OF 4 POPULATION GROUPS)
ANY GROUP > AGGRESSION INDEX THRESHOLD ?
YES
STOP

SOCIAL CONFLICT SUBROUTINE C-9

SOCIAL CONFLICT SUBROUTINE

This subroutine is intended to generate a propensity for destructive social conflict in the community. While there is without doubt a certain level of social conflict implicit in increased community involvement our concern in this subroutine is with disruptive, 'unhealthy' conflict levels. The subroutine output is a rough indicator of propensity for high level social conflict; it is not sufficiently detailed to give scale values.

A community history judgment of incidence of destructive social conflict is input to the subroutine from the Data Bank. A recent precedent of destructive social conflict is one of the three contributors to social conflict propensity, although like the others it is not absolutely necessary. This input is not affected by Title I.

Socio-economic grievances are a second factor. It should be noted that actual socio-economic inequalities are not as relevant as perceptions of socio-economic opportunity. Means by population group of perception of socio-economic opportunity (from the Instructional Process Submodel) are compared by taking the range of the means, an indicator of the spread of the disparity. The range threshold is set by model calibration. If, at a later date, research demonstrates that this part of the subroutine has greater predictive value, we may be able to connect size of range of the means with specific levels (scope and intensity), rather than employ the present simple threshold test (YES, NO).

In addition we need an attitudinal indicator of aggressive action orientation. A rough index is computed from the Identification With Authority (not orientation to authority) and confidence in logical world.* The two scales are multiplied in accordance with the hypothesis that a high score on both is necessary for an aggression index. This index is computed for each population group so that high values will not be washed out by aggregation. A high aggression index value for any group is considered sufficient to contribute to community social conflict.

---

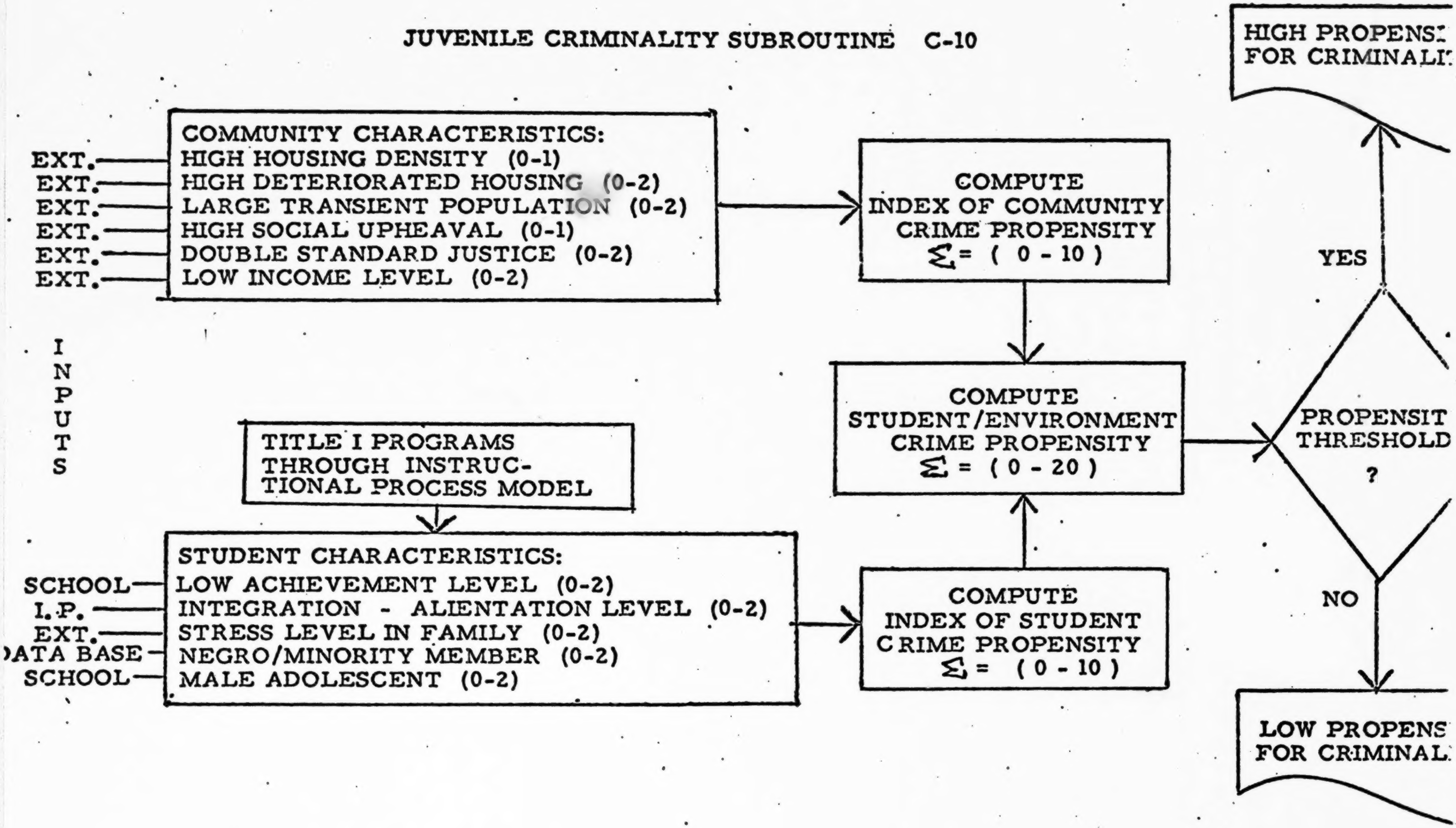
*This variable is a more general version of "Negative Attitude toward Science" found by Adorno, et. al., (The Authoritarian Personality, Harper, 1950, p. 464) to be highly correlated with high Ethnic Prejudice Scores and to some extent with aggressive behavior. The advantage in using "confidence in worldly logic" is that it is less tied to factual scientific knowledge.

Keeping in mind the roughness of these three indices, we consider the presence of a "YES" on any one factor an indication of low propensity, two "YES's" medium propensity, three "YES's" high propensity.

School-job coordinators input to the School Model is a good example of how Title I may affect disparity of perception of socio-economic opportunity. Good job coordination guidance could be expected to raise low means for certain groups of perception of socio-economic opportunity.

Similarly a school-job coordinator or other Title I program may affect "confidence in a logical world" and by increasing the denominator of the Aggression Index computation lower the index value. If either or both of these changes lowers the index value to less than the threshold value, we can expect a reduction of propensity for social conflict.

JUVENILE CRIMINALITY SUBROUTINE C-10


COMMUNITY CHARACTERISTICS:
HIGH HOUSING DENSITY (0-1)
HIGH DETERIORATED HOUSING (0-2)
LARGE TRANSIENT POPULATION (0-2)
HIGH SOCIAL UPHEAVAL (0-1)
DOUBLE STANDARD JUSTICE (0-2)
LOW INCOME LEVEL (0-2)
EXT.
EXT.
EXT.
EXT.
EXT.
EXT.
INPUTS
TITLE I PROGRAMS THROUGH INSTRUCTIONAL PROCESS MODEL
STUDENT CHARACTERISTICS:
LOW ACHIEVEMENT LEVEL (0-2)
INTEGRATION - ALIENTATION LEVEL (0-2)
STRESS LEVEL IN FAMILY (0-2)
NEGRO/MINORITY MEMBER (0-2)
MALE ADOLESCENT (0-2)
SCHOOL
I.P.
EXT.
ATA BASE
SCHOOL
COMPUTE INDEX OF COMMUNITY CRIME PROPENSITY Σ = (0 - 10)
COMPUTE STUDENT/ENVIRONMENT CRIME PROPENSITY Σ = (0 - 20)
COMPUTE INDEX OF STUDENT CRIME PROPENSITY Σ = (0 - 10)
PROPENSIT THRESHOLD ?
YES
NO
HIGH PROPENS FOR CRIMINALI
LOW PROPENS FOR CRIMINAL

CRIME SUB-ROUTINE

✓ Results from empirical research attempting to establish universal or area causes (e.g. personality based, physiologically based) of criminal behavior have been uniformly disappointing. Researchers and theoreticians have been unable to isolate clear cut causes of crime. It is felt that this is due to cultural and individual differences which interact in differing ways. Attempting to cut across such differences may well involve the summation of variables which negatively correlate with one-another, ✓ thus cancelling out each other when aggregated.

A second approach which does not attempt to establish causative relationships seeks to determineconditions under which criminal behavior is most likely to emerge. Here correlations rather than causes are the basis of examination. The Crime Sub-Routine makes use of information about certain variables which appear to be significant corollaries to crime. Based upon the literature the variables are divided into two groupings: Community and Student characteristics. Then variables in each of the sub-groups are weighted as contributing either 1 or 2 points. Data is insufficient to justify using any stronger mathematical treatment than summation. It is assumed that the greater the number of conditions favorable to crime for a defined population, the greater the probability that criminal behavior will occur for a segment of that population. Thus, when conditions cumulate to 15 or more points on a 20-point scale, the outcome is probabilistically assumed to be criminal behavior. Where such is the case, exogenous OE programs likely to deal with the corollaries to crime are recommended; following development of such programs, the student population characteristics are updated and returned to the Data Base and crime propensities recalculated.

Use of the scale requires the user to determine the characteristics of his community as described. If for example his school system is in a neighborhood with high-density but well kept homes, he would score 2 points for Housing Density and 0 for Deteriorated Housing. The maximum score for all community characteristics is 10; likewise for student characteristics. Where the sum of all propensity indicators exceeds 15, the Crime Decision Function outputs an increased propensity for criminal behavior.

The following studies provide the rationale for the variables included in the Community and Student Characteristics boxes: High Housing Density, High Deteriorated Housing, High Transient Population, High Ethnic Heterogeniety and High Social Upheaval are all reported by Freedman et al, 1956, as being correlated with criminal and delinquent behavior in the city. It is in areas so characterized that a disproportionate amount of crime is perpetrated, and where the greatest number of convictions are generated. Aside from empirical studies of correlations, police records support these variables as corresponding to the individual criminal behavior. These groups, it may be speculated, are also most vulnerable to the pressures of organized criminal activity. The existence of a double standard of justice (as for example with Negro populations) is considered by many psychologists and legal specialists as both reinforcing criminal behavior, and as a basis for disregard of civil rights by police, leading to further reinforcement.

Turning to the more individually oriented variables contained in the student characteristics box, the following empirical support exists. Raab and Selznick, 1959, found that low identification with society as seen in broken homes and marriages, lack of integration with neighborhood, etc., was significantly correlated to delinquency rates. Sykes, 1956, reports that frequently the problem of delinquency rate is a function not of deviate behavior from a total society, but rather of conformity to a primary peer group which promotes behaviors inconsistent with society; i.e., a cultural-subculture discrepancy. Crime rates are also very high among adolescents, particularly among males, as contrasted with other age groups (and females)--See Cressey, 1961. Work by Cohen and Short, 1961, indicates that among minority groups and particularly Negroes crime is disproportionately high.

Working Paper
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NATIONAL CENTER FOR EDUCATIONAL STATISTICS
Division of Operations Analysis

A COST-EFFECTIVENESS MODEL FOR THE ANALYSIS OF TITLE I ESEA PROJECT PROPOSALS

PART V

THE COST SUBMODEL

Prepared for the Division of Operations Analysis

by

Abt Associates, Inc.
Under Contract No. OEC 1-6-001681-1681

Technical Note
Number 18
December 9, 1966

OFFICE OF EDUCATION/U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

NATIONAL CENTER FOR EDUCATIONAL STATISTICS
Alexander M. Mood, Assistant Commissioner

DIVISION OF OPERATIONS ANALYSIS
David S. Stoller, Director

PREFACE

This Technical Note is the fifth part of a seven-part issue which describes a Cost-Effectiveness Model for the analysis of Title I ESEA Project Proposals. The seven parts are:

TN-14	Part I -	An Overview of the Cost-Effectiveness Model and Submodels for the Evaluation of Title I ESEA Proposals
TN-15	Part II -	The School Submodel
TN-16	Part III-	The Instructional Process Submodel
TN-17	Part IV -	The Community Submodel
TN-18	Part V -	The Cost Submodel
TN-19	Part VI -	The Effectiveness Submodel
TN-20	Part VII-	The Simulation

The model was developed by Abt Associates, of Cambridge, Massachusetts, for the Division of Operations Analysis, National Center for Educational Statistics, under contract number OEC 1-6-001681-1681.

THE COST SUBMODEL

In order to assign meaningful cost-effectiveness weightings to a proposed Title I program, the Cost Sub-Model has been developed. This model is designed to compute the total cost of a Title I program including both direct and indirect expenditures required for the program. Actual average costs of direct requirements, such as reading machines, teachers' salaries, salaries of health personnel, audio-visual equipment, etc. will be stored in the data base of the model for every Title I program which the model will be able to handle.

In addition, costs of supporting requirements, such as an empty classroom and additional administrative personnel oftentimes available within the school system itself, though not necessarily taken into consideration by the user, will be stored with each program package. Hence, when a Title I program is introduced into the Cost Model, not only its direct requirements, but also its supporting requirements will be examined. As illustrated by Figure II, the model will compare current resources available in the school with their utilization rate to arrive at an evaluation of resources available to fulfill supporting requirements for the Title I program. Thus, when the cost computation is executed, total cost of the project is obtained, not just the obvious cost of the major portion of the program in question.

The methodology to be used by the Cost Sub-Model in determining this total cost figure is outlined in Figure III. Both direct and indirect purchases required for the program package are listed, including both the initial expenditure required for the first year of operation and the discounted present value of the future costs where applicable. These costs are printed out for the benefit of the user according to the format in Figure III. Total cost of the package is also sent to the cost-effectiveness sub-model as an input to be used in calculating relative cost-effectiveness measures.

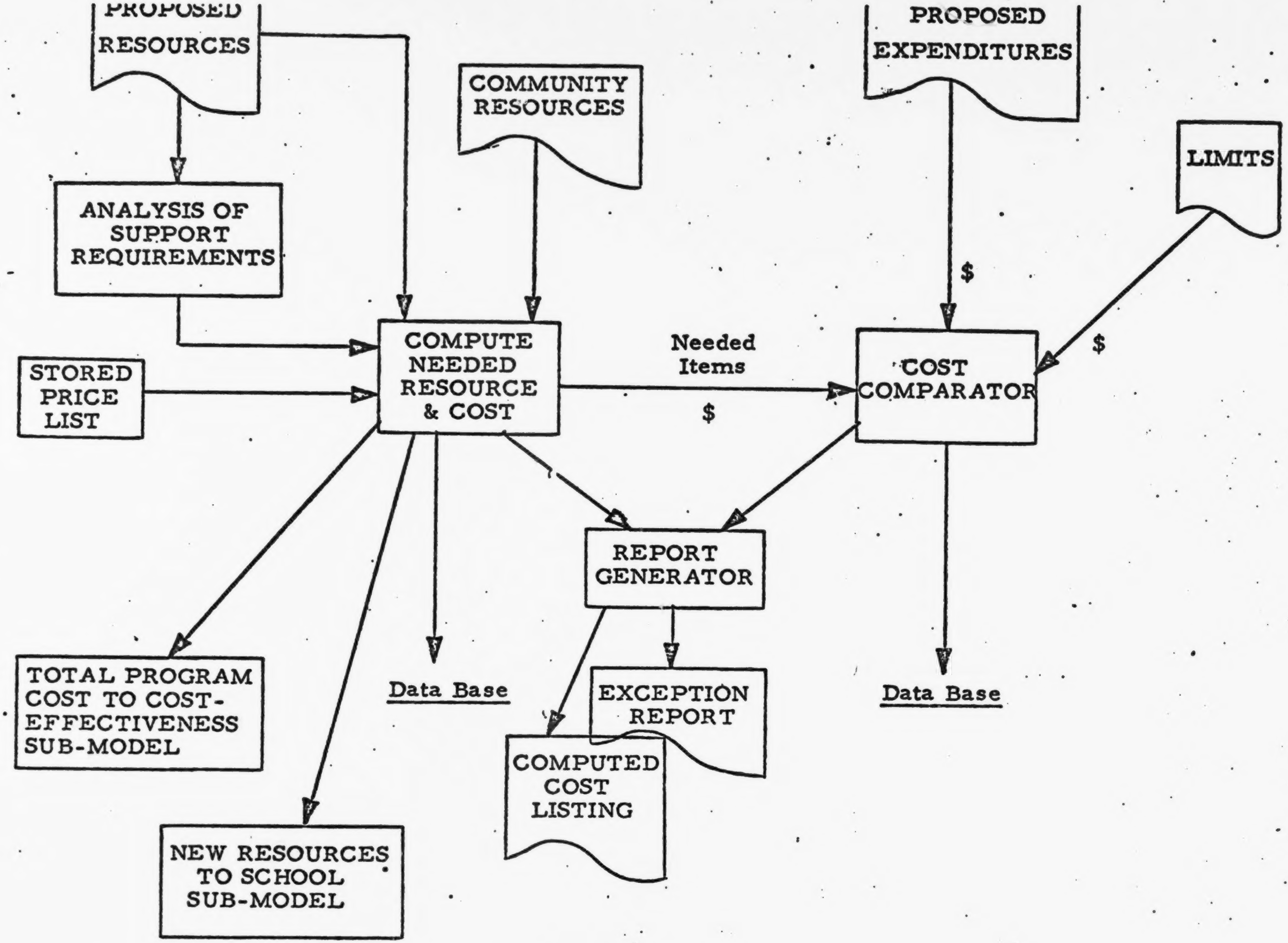

PROPOSED RESOURCES
ANALYSIS OF SUPPORT REQUIREMENTS
STORED PRICE LIST
COMMUNITY RESOURCES
COMPUTE NEEDED RESOURCE & COST
Needed Items
$
PROPOSED EXPENDITURES
$
LIMITS
$
COST COMPARATOR
REPORT GENERATOR
TOTAL PROGRAM COST TO COST-EFFECTIVENESS SUB-MODEL
Data Base
EXCEPTION REPORT
COMPUTED COST LISTING
Data Base
NEW RESOURCES TO SCHOOL SUB-MODEL

FIGURE I

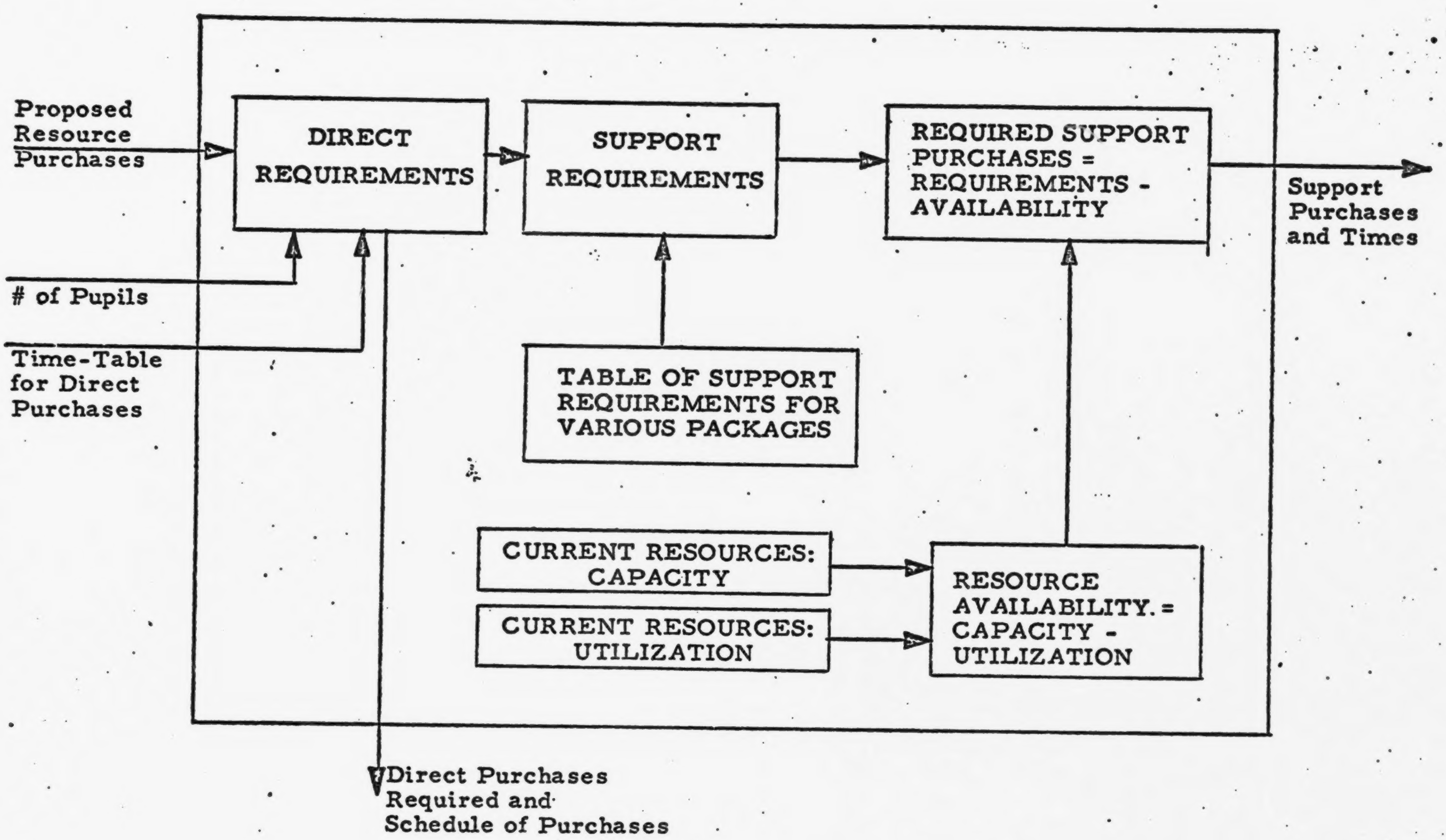
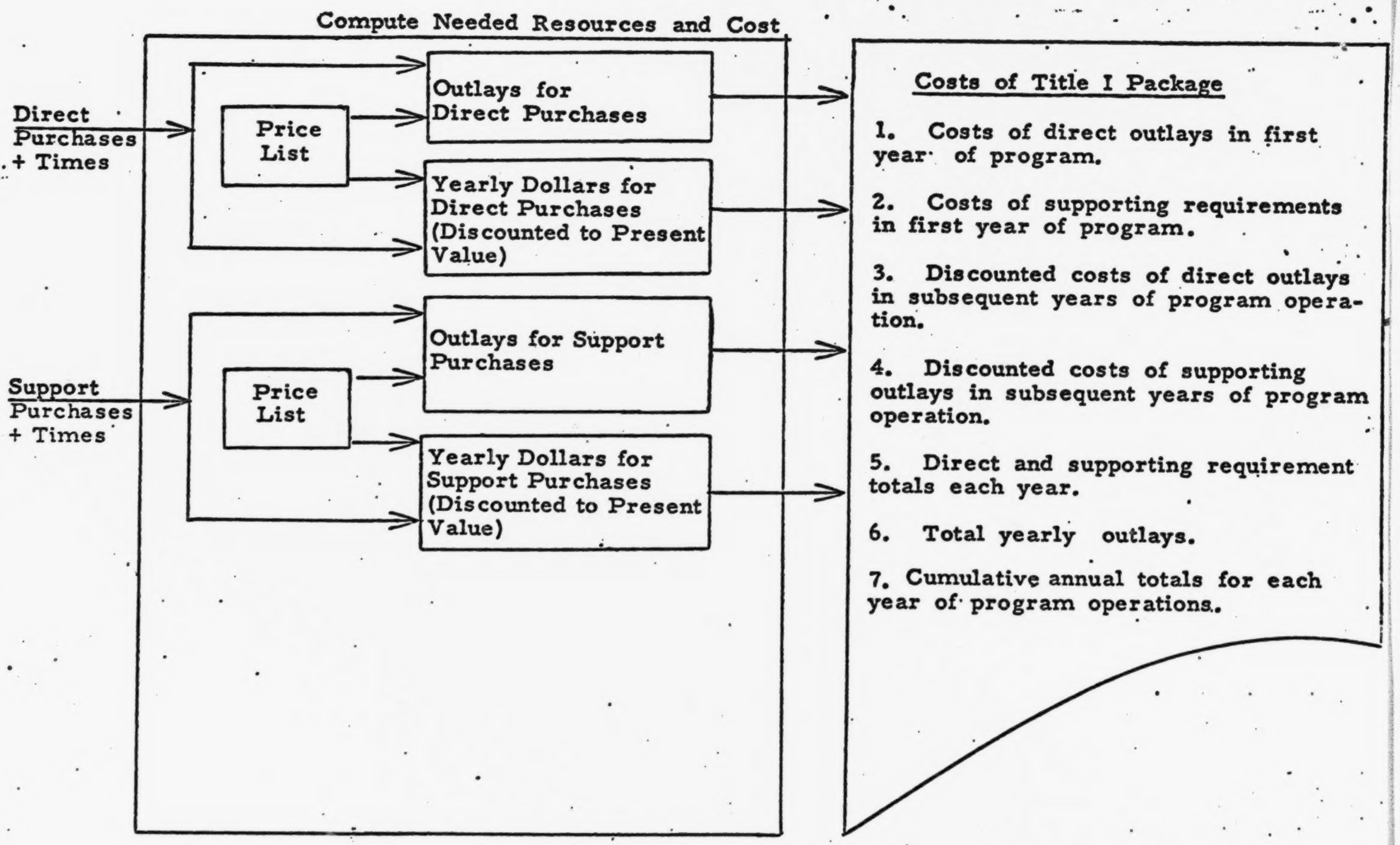

Proposed
Resource
Purchases
DIRECT
REQUIREMENTS
SUPPORT
REQUIREMENTS
REQUIRED SUPPORT
PURCHASES =
REQUIREMENTS -
AVAILABILITY
Support
Purchases
and Times
# of Pupils
Time-Table
for Direct
Purchases
TABLE OF SUPPORT
REQUIREMENTS FOR
VARIOUS PACKAGES
CURRENT RESOURCES:
CAPACITY
CURRENT RESOURCES:
UTILIZATION
RESOURCE
AVAILABILITY. =
CAPACITY -
UTILIZATION
Direct Purchases
Required and
Schedule of Purchases

FIGURE II — ANALYSIS OF SUPPORT REQUIREMENTS


Compute Needed Resources and Cost
Direct Purchases + Times
Price List
Outlays for Direct Purchases
Yearly Dollars for Direct Purchases (Discounted to Present Value)
Support Purchases + Times
Price List
Outlays for Support Purchases
Yearly Dollars for Support Purchases (Discounted to Present Value)

Costs of Title I Package

1. Costs of direct outlays in first year of program.

2. Costs of supporting requirements in first year of program.

3. Discounted costs of direct outlays in subsequent years of program operation.

4. Discounted costs of supporting outlays in subsequent years of program operation.

5. Direct and supporting requirement totals each year.

6. Total yearly outlays.

7. Cumulative annual totals for each year of program operations.

FIGURE III

Once the total cost of the program has been determined, this cost estimate will be compared with the cost estimates prepared by the user in those cases where he has already estimated the cost of the project, and discrepancies between the two estimates will be listed for the user. In addition, the total cost of the program will be compared with the total supply of funds available for the project and if the cost estimate exceeds the expenditure limit, the computer will stop and indicate this fact to the user. (Refer to Figure IV) Both of these diagnostic routines serve as a check to the user when the cost of the program is significantly greater than the amount of money he had originally planned to expend.

The cost sub-model is integrated with both the instructional process and exposure sub models. The program package being evaluated is fed into the instructional process sub model after its characteristics are translated in a series of descriptors able to be processed by the instructional process model. The exposure sub-model receives the new resources which the cost model indicates are required to execute the Title I program in question, and updates the data base accordingly. The exposure model also supplies the cost model with the number of students included in a particular target group selected by the user as the recipients of the Title I program, thereby allowing the cost model to determine the quantity (and thereby costs) of resources required in any given Title I program.

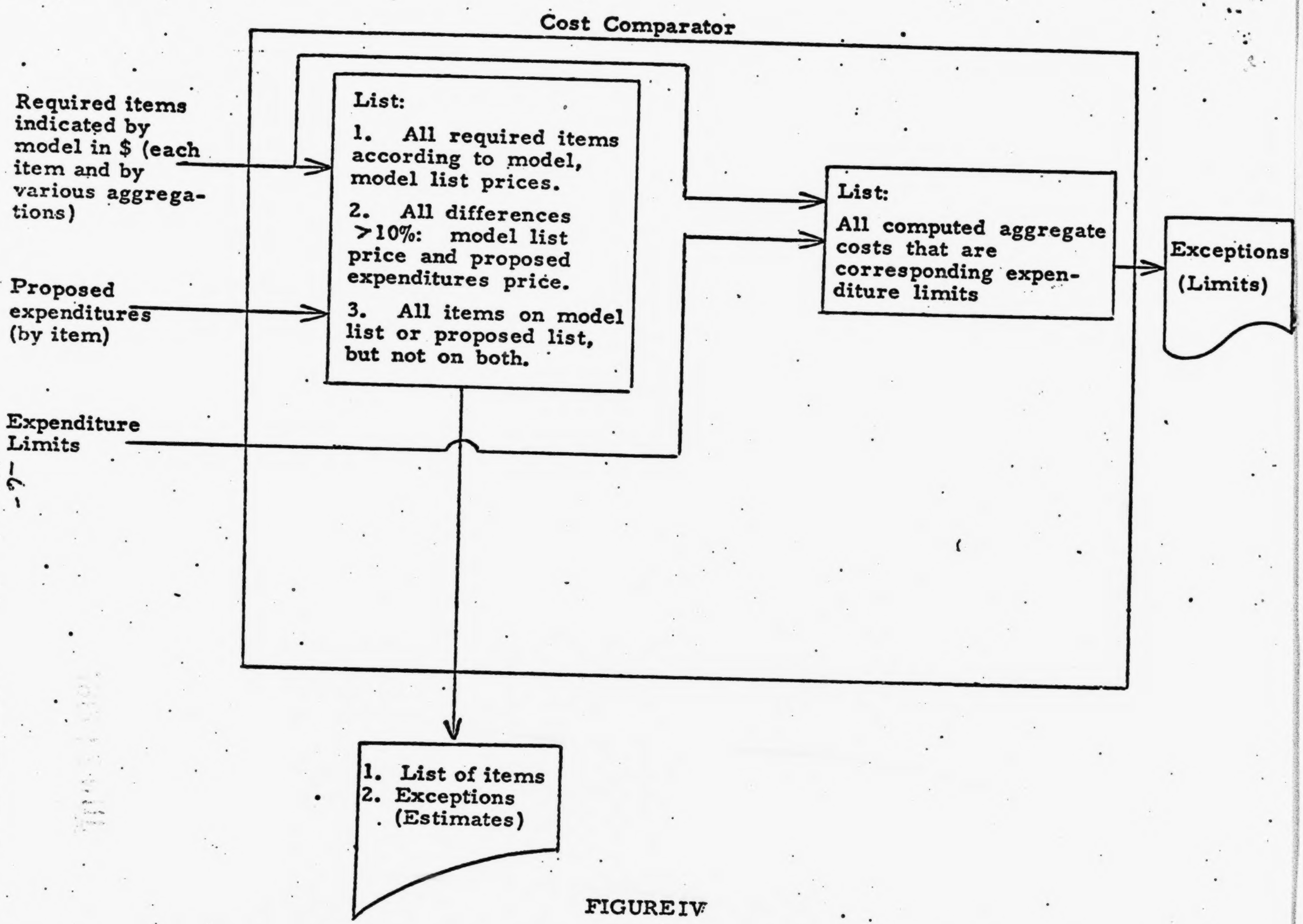

Cost Comparator
Required items indicated by model in $ (each item and by various aggregations)
Proposed expenditures (by item)
Expenditure Limits
List:
1. All required items according to model, model list prices.
2. All differences >10%: model list price and proposed expenditures price.
3. All items on model list or proposed list, but not on both.
List:
All computed aggregate costs that are corresponding expenditure limits
Exceptions (Limits)
1. List of items
2. Exceptions (Estimates)

FIGURE IV

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PART VI

THE EFFECTIVENESS SUBMODEL

Prepared for the Division of Operations Analysis

by

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Technical Note
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TN-19 Part VI - The Effectiveness Submodel

TN-20 Part VII- The Simulation

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THE EFFECTIVENESS SUBMODEL

The overall model will simulate particular school districts and their output in terms of student changes and community impacts. This simulation is done, in particular, by the School submodel, the Instructional Process submodel and the Community submodel. The Cost submodel determines the costs of the various Title I inputs and the on-going school expenses. It is the job of the Effectiveness submodel to receive the outputs of these four submodels and the updated data base and provide output for the user.

What kinds of outputs are there?

Chart 1 shows two kinds of outputs which are generated by the simulation. If we operate the model without any Title I programs (the base run), the output will be in terms of pre-Title I levels; this type of student had an achievement level in math of such-and-such, for example. These pre-Title I levels are important for testing the model and tuning the judgment parameters in it - this is the first kind of output.

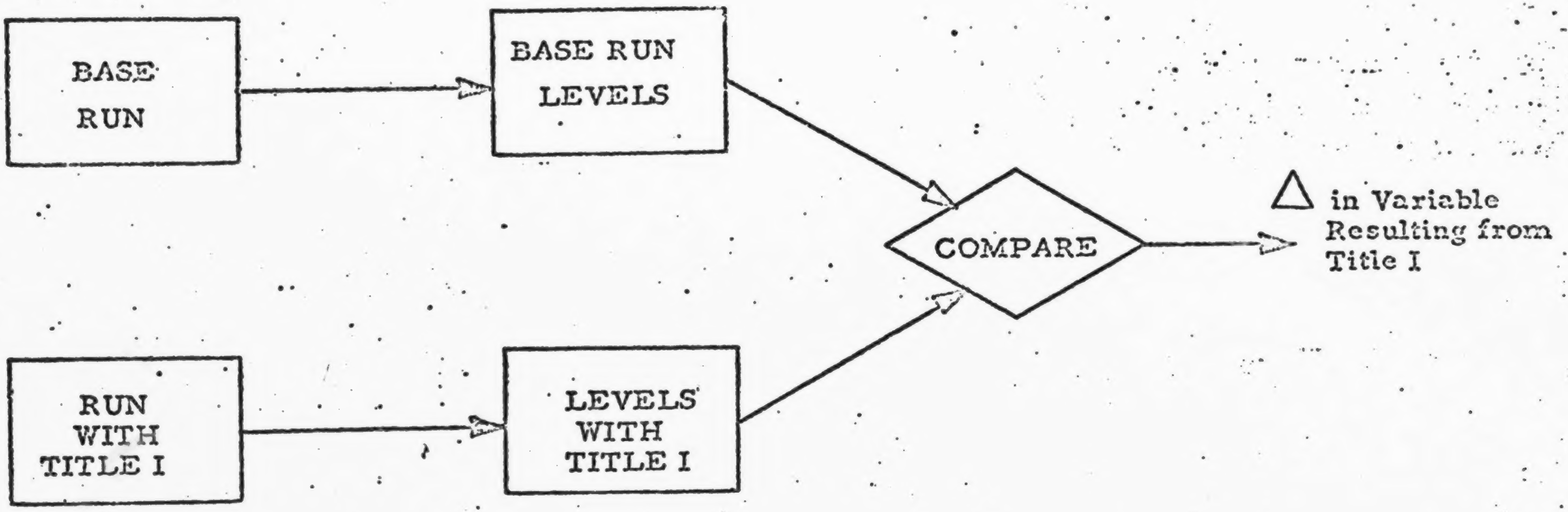
After making the base run, we will run the simulation with a proposed Title I program present. The output of this run will be another set of levels of student change and community impact, but these are not very useful by themselves. The information we seek describes the impact of the possible Title I program on the school. The only way to determine this is to compare the base run with the Title I run.

Thus, the second kind of output derived from the simulation is a set of changes (or deltas) for each of the variables of interest. Let us examine the two kinds of outputs in detail, and see what they consist of.

Baseline output

Chart 2 shows the baseline output for a target population consisting of the fourth grade in a particular school. Described are:

The target population
A set of aggregate results
Results broken down in detail


BASE RUN
BASE RUN LEVELS
RUN WITH TITLE I
LEVELS WITH TITLE I
COMPARE
Δ in Variable Resulting from Title I

EXAMPLES:

FOURTH
GRADE

READING LEVEL =
SECOND GRADE

FOURTH
GRADE Δ

Δ READING LEVEL =
+ ONE GRADE

CHART 1 - SIMULATION RESULTS

BASELINE RESULTS

TARGET POPULATION: 4th GRADE

AGGREGATE RESULTS - GRADE 4

ACHIEVEMENT LEVEL (I.Q.)	95
READING LEVEL	3rd GRADE
SOCIAL ADJUSTMENT	POOR
MATH SKILL	POOR
LANGUAGE SKILL	POOR
PERSONALITY DEVELOPMENT	FAIR
EMOTIONAL CONTROL	POOR

DISTRIBUTED RESULTS - GRADE 4

	TYPE NUMBER			
	1	2	3	4
ACHIEVEMENT	95	95	100	110
READING	3	3	3	4
SOCIAL ADJUSTMENT	P	P	P	G
MATH	P	P	P	G
LANGUAGE	P	P.	F	G
PERSONALITY	F	F	P	G
EMOTION	P	P	F	G
STUDENT POPULATION	75	50	20	10

CHART 2 - BASELINE OUTPUT

This baseline output shows the target population at a particular point in time. It is a snapshot of the fourth graders; its source is the instructional process model. Another type of baseline output is that provided by the school model. Chart 3 shows the curriculum flow network for the school in question and lets us see what the expected future is for the children in question without Title I inputs.

Chart 4 shows the delta results derived from the simulation and the outputs which are drawn from them. We are interested in the effects which occur as a result of the introduction of the Title I input. (Effects and Resources). However, this sort of output may not be very useful for comparison of alternative Title I programs, since different resources are likely to be used by different programs. It is therefore necessary to convert resources into some common unit; the most obvious unit is that of dollars. We can then calculate the effect per dollar change; a useful number. For the same reason that we converted resources into common units, it is necessary to convert effects into common units; that is, we want to compare alternative programs with different effects and resources along some common dimension.

The unit for the comparison of effects is value. The value for changes in the various effects is of course a judgment input - this input may be obtained from the user by means of the Churchman-Ackoff approximate measure of value procedure or other means. Given changes in effects weighted by their associated values and the resource changes described in terms of dollars, we can derive the necessary index of value/dollar derived from the Title I program.

In the case where only one resource (e.g., textbooks, teachers, schoolrooms, etc.) is being introduced by a Title I program, the amount of a value resulting from an increased unit of that resource may be a desirable output.

What do these outputs look like?

Chart 5 shows the information needed to determine the incremental value per dollar which results when a Title I program is introduced into a school. The total cost of the program, the magnitude of the effects derived

CHART 3.
LONG RANGE EDUCATIONAL EFFECTS

Before Title I: Low Income - Negro

Reading	x xKx	x x1x	x x1x	x x2x	x x2x	x x3x	x x3x	x x4x	x x4x	x x4x	x x4x	x x4x
Language	x	x xKx	x x1x	x x1x	x x2x	x x2x	x x3x	x x3x	x x4x	x x4x	x x4x	x x4x
Soc. studies		x			x x1x	x x2x	x x3x	x x4x	x x4x	x x4x	x x4x	x x4x
Math	x xKx	x xKx	x x1x	x x1x	x x2x	x x2x	x x3x	x x3x	x x4x	x x4x	x x4x	x x4x
Science					x1x	x2x	x3x	x4x	x4x	x4x	x4x	x4x
	1	2	3	4	5	6	7	8	9	10	11	12

grade

Title I Program: Headstart for Low Income - Negro

Reading	1	2	3	4	5	6	7	x8x	x8x	x8x	x8x	x8x
Language		2	3	4	5	x5x	x6x	x7x	x7x	x7x	x7x	x7x
Soc. studies					5	6	x6x	x6x	x7x	x7x	x7x	x7x
Math	x xKx x	x x1x x	x x2x x	x x3x x	x x4x x	x x5x x	x x6x x	x x7x x	x x7x x	x x7x x	x x7x x	x x7x x
Science					x x3x	x x4x	x x5x	x x6x	x x7x	x x7x	x x7x	x x7x
	1	2	3	4	5	6	7	8	9	10	11	12

grade

The shadow cast over the entire performance before headstart has been partially removed. Remedial Arithmetic would further increase achievement but secondary school failure may still be possible due to low relative achievement and poor attitude toward school.

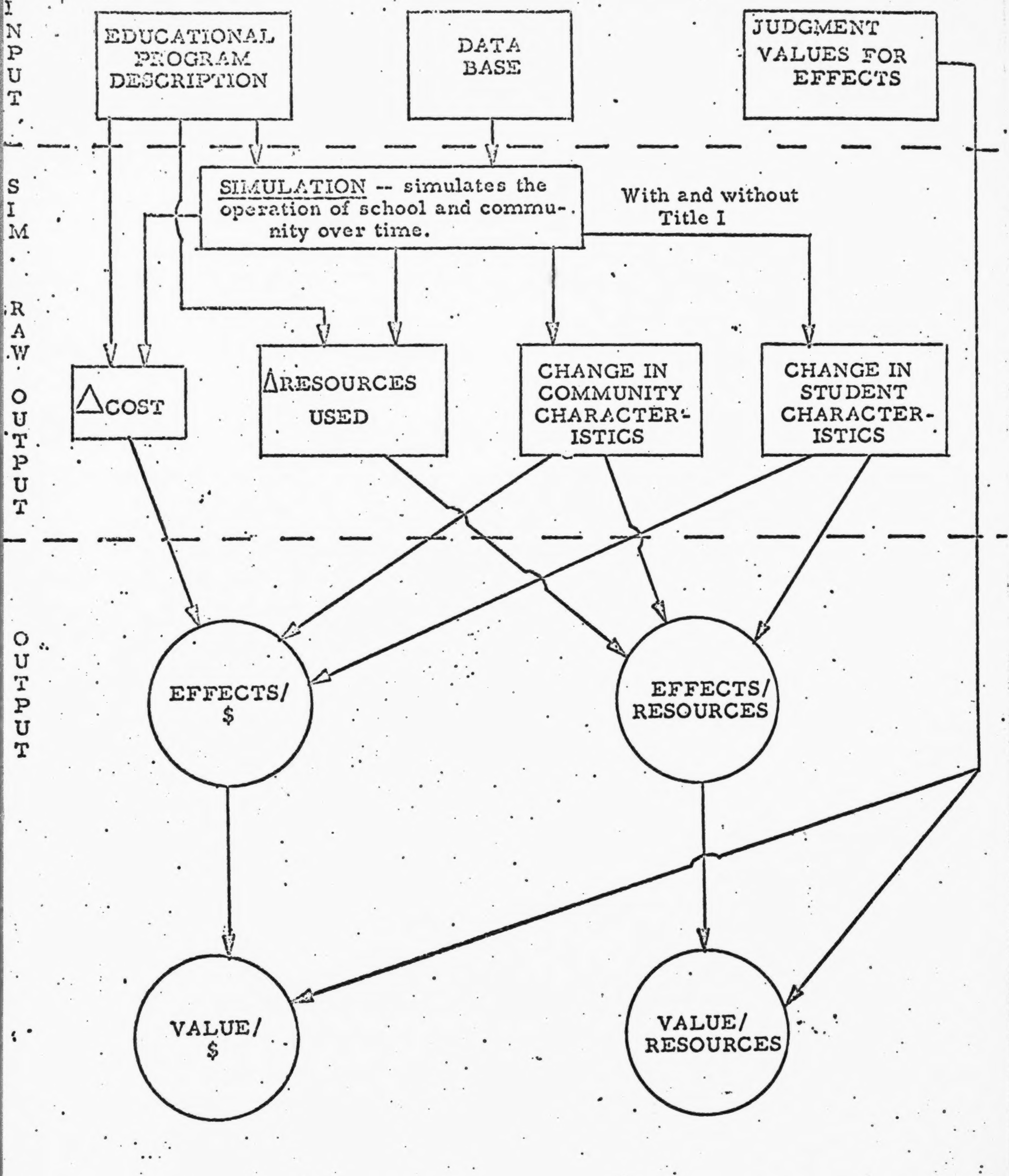

INPUT
SIM.
RAW OUTPUT
OUTPUT
EDUCATIONAL PROGRAM DESCRIPTION
DATA BASE
JUDGMENT VALUES FOR EFFECTS
SIMULATION -- simulates the operation of school and community over time.
With and without Title I
ΔCOST
ΔRESOURCES USED
CHANGE IN COMMUNITY CHARACTERISTICS
CHANGE IN STUDENT CHARACTERISTICS
EFFECTS/ $
EFFECTS/ RESOURCES
VALUE/ $
VALUE/ RESOURCES

CHART 4 ΔOUTPUTS FROM THE SIMULATION

COMMUNITY: FERNDALE, MASSACHUSETTS

TITLE I PROGRAMS:
A. TEACHER INCREASE
B. AUDIO-VISUAL DEVICES
C. TV SETS
D. NEW TEXTBOOKS

VALUE/$ TABLE:

PROGRAM	COST	TOTAL VALUE	VALUE/ $ X 10^4	REFER. PAGE
A	$50,000	65	13	23
C	70,000	10	10	25
B	15,000	12	8	24
D	5,000	3	6	26

VALUE BY EFFECTS TABLE:

PROGRAM	VALUE FROM ACHIEVEMENT Δ'S					FROM ATTITUDE Δ'S			FROM CON.		TOTAL
	SCIENCE	MATH	SOCIAL STUDIES	ENGLISH	READ-ING	LOGICAL WORLD	N-ACHIEV	SELF ESTEEM	TRUST	SOC. CONF.	
A	5	5	6	6	6	11	8	10	7	1	65
B	1	1	2	3	4	1	--	--	--	--	12
C	1	1	1	2	3	1	--	--	--	--	10
D	--	--	3	--	--	--	--	--	--	--	3

CHART 5 - VALUE/$ TABLE

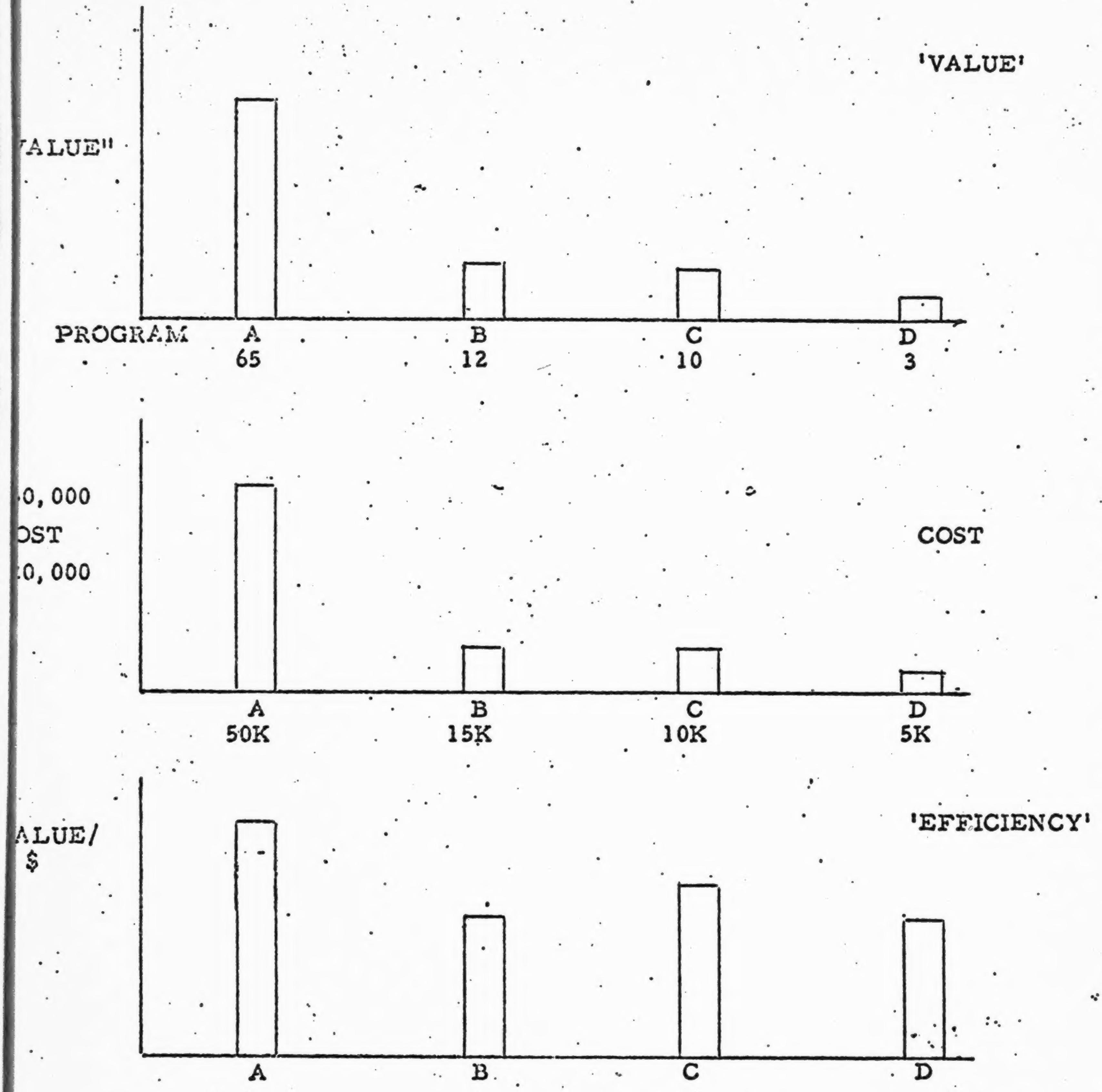


CHART 5A - VALUE/DOLLAR GRAPH

and the relative values of changes in the effects variables are necessary. The value-weighted changes are summed and this total is divided by the total cost to give value/dollars. Chart 5A is a graphical representation of this information.

Chart 6 shows how effects and total cost may be related.

In Chart 7, we see the combination of Effects and Resources in the case where more than one resource has been used. This output is essentially a list of effects and resources with little demonstration of tradeoffs. Chart 8, on the other hand, gives a possible output which we might see when only one resource has been used in a Title I program. In each case, the simple calculation of value and resource is appended to the output.

COMMUNITY: FERNDALE, MASSACHUSETTS

TITLE I PROGRAMS:
- A. TEACHER INCREASE
- B. AUDIO-VISUAL DEVICES
- C. TV SETS
- D. NEW TEXTBOOKS

EFFECTS/$ RELATIVE MEASURE (X 10^{-4})

PROGRAM	ACHIEVEMENT Δ'S					ATTITUDE Δ'S				COMM. Δ'S
	SCIENCE	MATH	SOCIAL STUDIES	ENGLISH	READ-ING	LOGICAL WORLD	N-ACHIEV.	SELF-ESTEEM	TRUST	SOCIAL CONFLICT
A	12	68	40	38	46	22	51	46	20	12
B	2	14	10	20	15	5	--	--	--	--
C	23	37	22	12	14	7	--	--	--	--
D	--	--	92	--	--	--	--	--	--	--

CHANGE IN ACHIEVEMENT LEVEL/$
BY PROGRAM AND EFFECT

EFFECTS/DOLLAR TABLE -
CHART 6

CHANGES GREATER THAN 1% IN VARIABLES (EFFECTS AND RESOURCES) BETWEEN BASE RUN AND RUN WITH TITLE I PROGRAM _____.

EFFECTS:

INCREASES	PERCENT
MATH ACHIEVEMENT	+ 10%
SOCIAL ADJUSTMENT	+ 5%
DECREASES	
LANGUAGE SKILL	- 2%

RESOURCES:

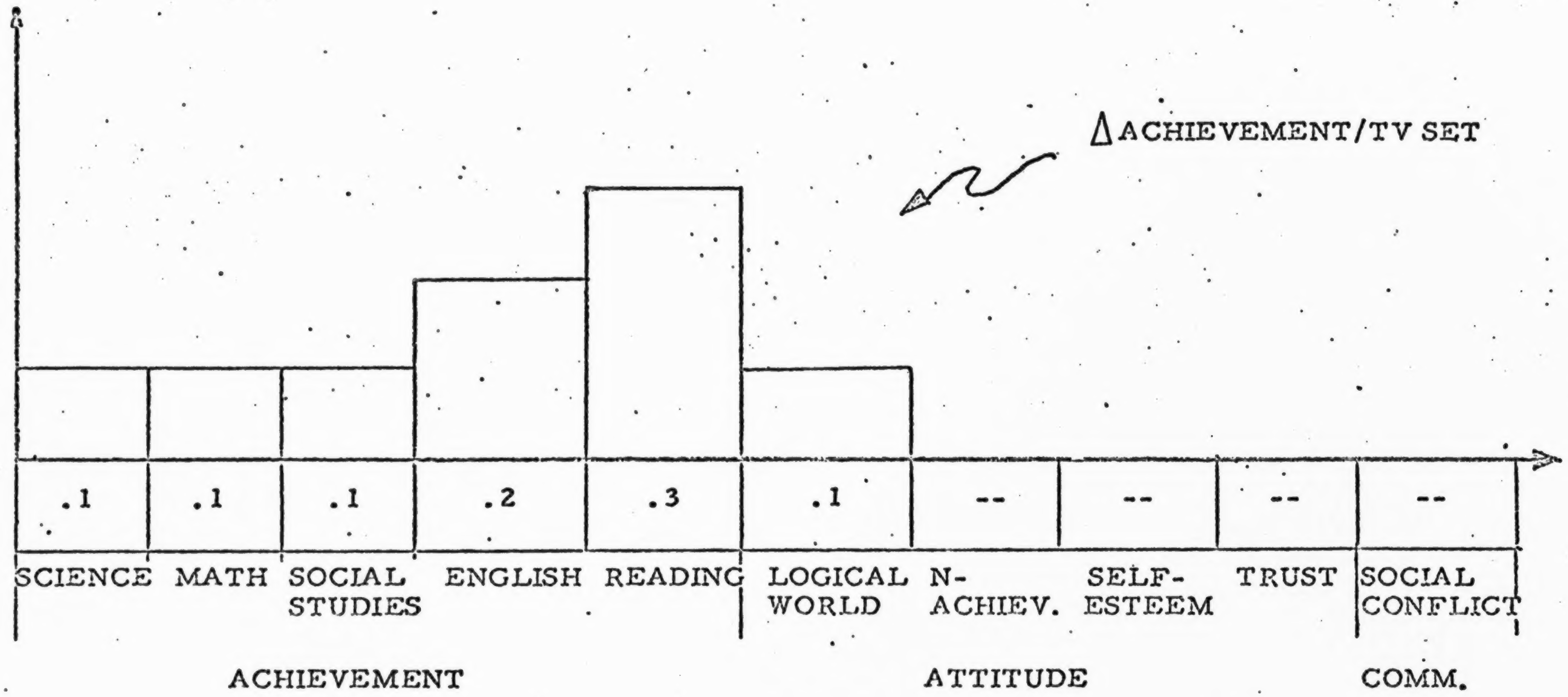
INCREASES	
TEACHERS	+ 10%
AUDIO-VISUAL DEVICES	+ 20%

(TOTAL CHANGE +54 VALUE UNITS)

CHART 7 - EFFECTS AND SEVERAL RESOURCE INPUTS

COMMUNITY: FERNDALE, MASSACHUSETTS
PROGRAM C. TV SETS

RESOURCE: 10 TV SETS



% CHANGE BY CATEGORY PER RESOURCE UNIT

CHART 8 - EFFECTS/RESOURCES OUTPUT

How does the simulation operate to produce these results?

Chart 9 shows the simulation and its operation. For further detail, on this rather technical side of the cost-effectiveness model design. See the memo written by Hodder and Miller which covers the subject in more detail.

A problem which may be of more interest to the user is: how does the simulation look to me? Chart 10 describes the interaction of the user and the computer from the data-gathering stage until the final output is received from the simulation. This chart also is described in the memo referenced above.

If the user desires more detailed information on the simulation process in general or the three parts of the computer program shown in Chart 9, this detail will also be found in the simulation memo. There are flowcharts which show, in more detail, the operation of each of the three parts of the computer operation of the overall evaluation tool.

COST-EFFECTIVENESS SIMULATION - OE

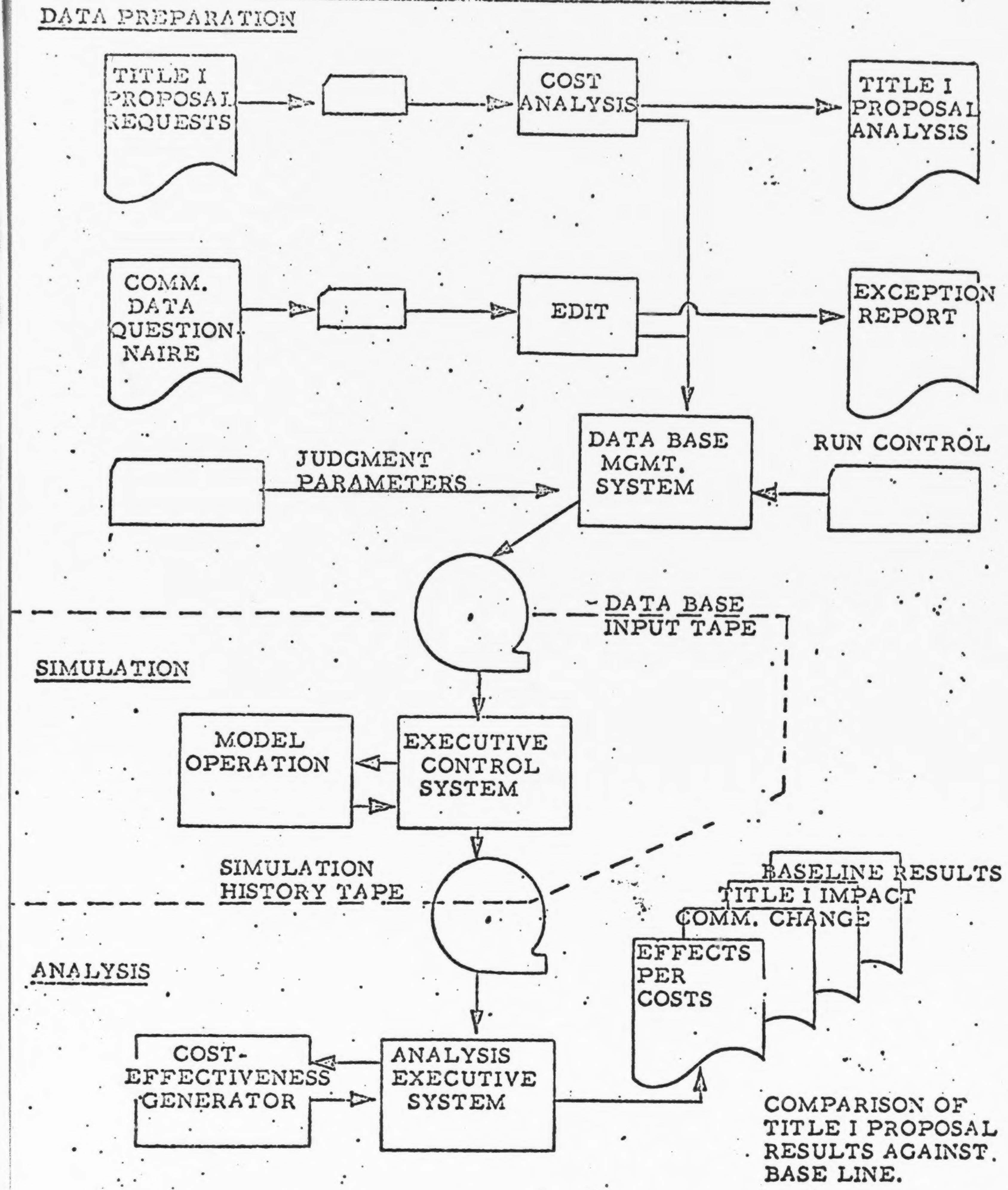

DATA PREPARATION
TITLE I PROPOSAL REQUESTS
COST ANALYSIS
TITLE I PROPOSAL ANALYSIS
COMM. DATA QUESTIONNAIRE
EDIT
EXCEPTION REPORT
JUDGMENT PARAMETERS
DATA BASE MGMT. SYSTEM
RUN CONTROL
DATA BASE INPUT TAPE
SIMULATION
MODEL OPERATION
EXECUTIVE CONTROL SYSTEM
SIMULATION HISTORY TAPE
BASELINE RESULTS
TITLE I IMPACT
COMM. CHANGE
EFFECTS PER COSTS
ANALYSIS
COST-EFFECTIVENESS GENERATOR
ANALYSIS EXECUTIVE SYSTEM
COMPARISON OF TITLE I PROPOSAL RESULTS AGAINST BASE LINE.

CHART 9

USER INTERACTION DIAGRAM

	Source	Operation
TA LLECTION	Field	Filled-out questionnaire and Title I proposal
	Data processing facility	Convert data to punched cards
	Machine processing	Run editing and cost analysis programs
	User error analysis	Determine corrections needed
TA SE REPARATION	User error correction	Prepare data decks
	User run control preparation	Prepare run deck
	Machine processing	Run data base management system
	Data processing facility	Save data base tape
PERATION	Machine processing	Run simulation Save output tape
NALYSIS	User data analysis	Data Analysis
	User request for additional information	Run analysis system with control card
	User analysis	Further detailed data analysis

Pictorial

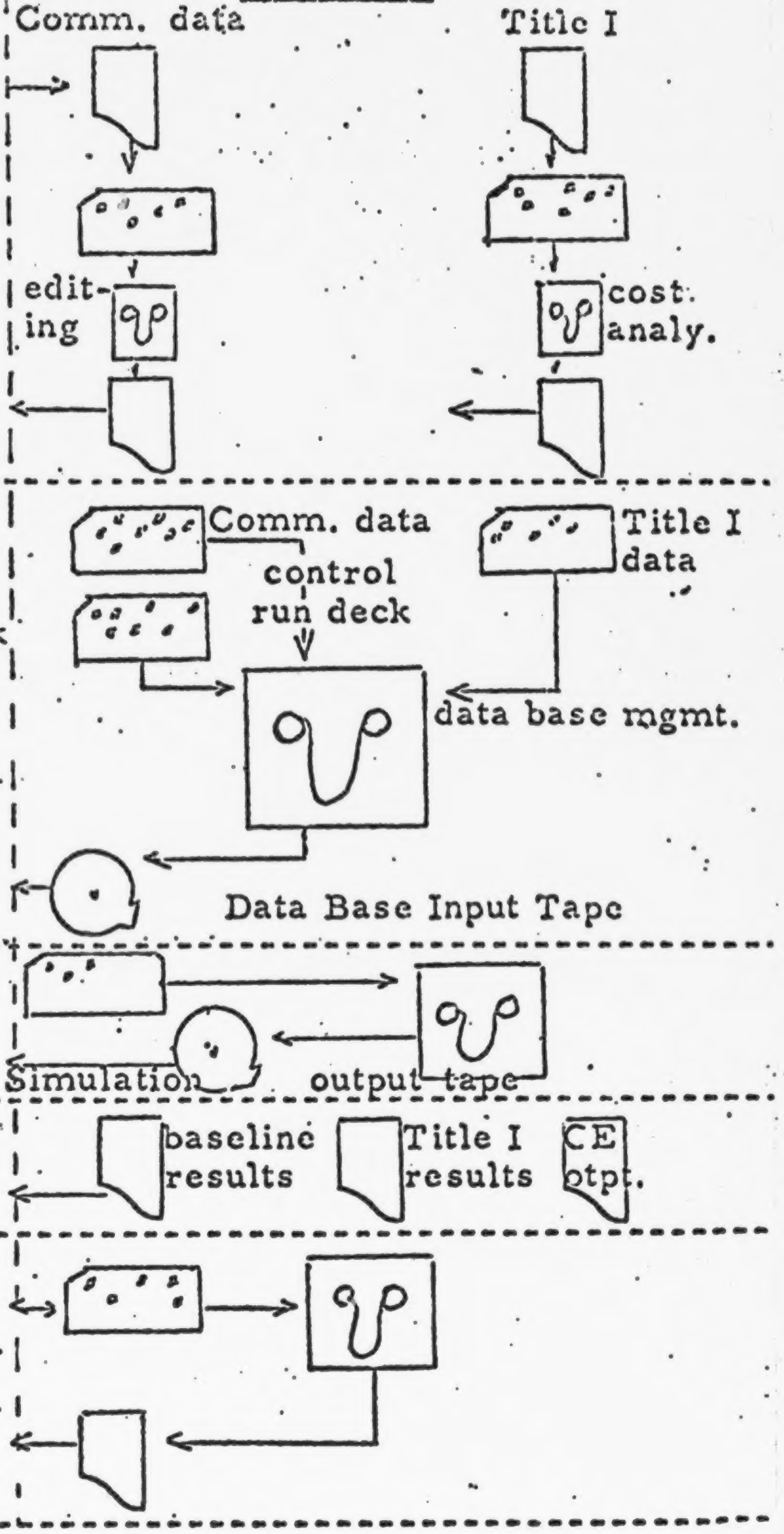

Comm. data
Title I
editing
cost analy.
Comm. data
Title I data
control run deck
data base mgmt.
Data Base Input Tape
Simulation
output tape
baseline results
Title I results
CE otpt.

CHART 10

Working Paper
Does Not Reflect
Official Policy of
The Office of Education

NATIONAL CENTER FOR EDUCATIONAL STATISTICS
Division of Operations Analysis

A COST-EFFECTIVENESS MODEL FOR THE ANALYSIS OF TITLE I ESEA PROJECT PROPOSALS

PART VII

THE SIMULATION

Prepared for the Division of Operations Analysis

by

Abt Associates, Inc.
Under Contract No. OEC 1-6-001681-1681

Technical Note
Number 20
December 9, 1966

OFFICE OF EDUCATION/U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

NATIONAL CENTER FOR EDUCATIONAL STATISTICS
Alexander M. Mood, Assistant Commissioner

DIVISION OF OPERATIONS ANALYSIS
David S. Stoller, Director

PREFACE

This Technical Note is the seventh part of a seven-part issue which describes a Cost-Effectiveness Model for the analysis of Title I ESEA Project Proposals. The seven parts are:

TN-14 Part I - An Overview of the Cost-Effectiveness Model and Submodels for the Evaluation of Title I ESEA Proposals

TN-15 Part II - The School Submodel

TN-16 Part III- The Instructional Process Submodel

TN-17 Part IV - The Community Submodel

TN-18 Part V - The Cost Submodel

TN-19 Part VI - The Effectiveness Submodel

TN-20 Part VII- The Simulation

The model was developed by Abt Associates, of Cambridge, Massachusetts, for the Division of Operations Analysis, National Center for Educational Statistics, under contract number OEC 1-6-001681-1681.

THE SIMULATION

1. Introduction

The simulation will be used by the Office of Education to evaluate programs in particular communities. It will not be used explicitly to allocate all Title I money in an optimal way; the model will not tell us to spend $300,000 in district A, $20,000 in district B, and so on for all of Title I. Rather it will tell the user that for community A, program 1 yields better results for less money than program 2. The simulation will be an evaluation and planning tool, not a research instrument.

The model will compare the effects and costs of programs or combinations of programs with a set of basic effects and costs which derive from the school districts' operation without changes. In computer terms, we will compare alternative program runs with the base run.

Although research use is not the goal of our model development effort, it will be necessary for the user to have the opportunity to investigate in depth the results of program's and the working of the model. This option for in-depth investigation will enable the user to develop his confidence in and facility with the model to whatever level of detail he desires. The user may have a particular area of interest in which he wishes to observe changes in variables which are not summarized in the print-out for the ordinary user. He should be able to investigate these changes.

The three areas of concern for the simulation are:

1) Data base preparation,
2) Model operation, and
3) Cost-effectiveness analysis and presentation of results.

These three areas are linked by three executive systems:

1) The Data Base Management System,
2) The Executive Control System for model operation, and
3) The Analysis Control System for cost-effectiveness computation and output display.

Each of the three executive systems handles the computer operations of data input, sequencing of activities, and generation of output.

Figure I shows these three systems separated by dashed horizontal lines. The Title I proposal and community data are connected to punched cards, examined for error, combined with the judgment parameters set by the designers, and assembled on the data base input tape. After model operation, the collected data is analyzed and user reports are produced.

COST-EFFECTIVENESS SIMULATION - OE

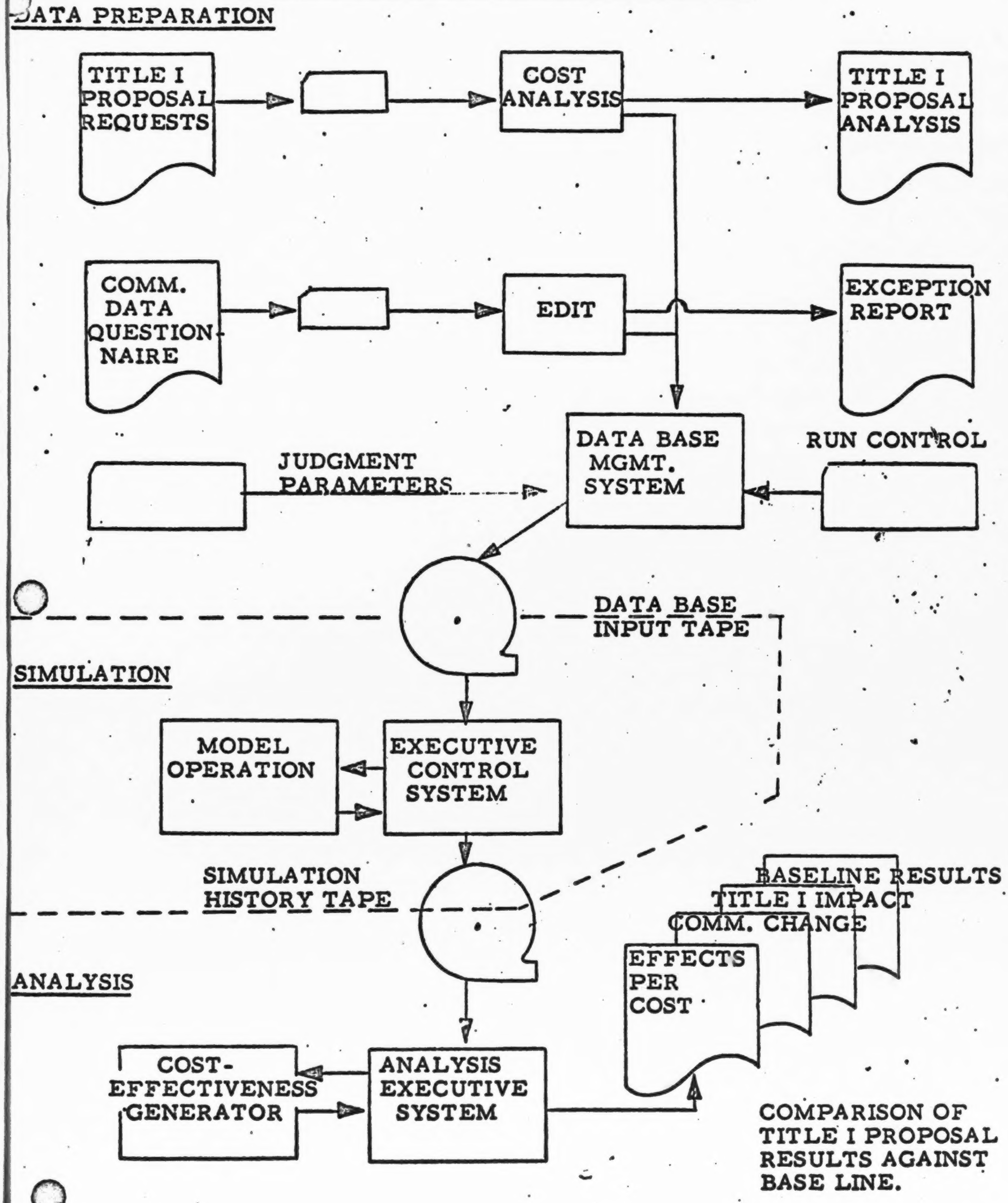

DATA PREPARATION
TITLE I PROPOSAL REQUESTS
COST ANALYSIS
TITLE I PROPOSAL ANALYSIS
COMM. DATA QUESTIONNAIRE
EDIT
EXCEPTION REPORT
JUDGMENT PARAMETERS
DATA BASE MGMT. SYSTEM
RUN CONTROL
DATA BASE INPUT TAPE
SIMULATION
MODEL OPERATION
EXECUTIVE CONTROL SYSTEM
SIMULATION HISTORY TAPE
ANALYSIS
BASELINE RESULTS
TITLE I IMPACT
COMM. CHANGE
EFFECTS PER COST
COST-EFFECTIVENESS GENERATOR
ANALYSIS EXECUTIVE SYSTEM
COMPARISON OF TITLE I PROPOSAL RESULTS AGAINST BASE LINE.

FIGURE I

2. User Interactions

The simulation has been designed to maximize the quality of the data used. Editing and analysis routines have been provided to check for errors of omission, inconsistencies, and reasonableness of both the Title I and community data.

Outputs are prepared automatically when exceptions occur, pinpointing source data errors. Model and Cost-Effective results are presented as overviews, but the simulation allows further in-depth analysis upon request without rerunning the model.

Community data is saved on the data base input tape. Title I results are saved on the simulation output tape. These two tapes separate the three main simulation areas. Operation of the data base management system results in the data base input tape, simulation operation results in the simulation output tape, and analysis results in user displays.

Figure II depicts the interaction points and shows the sequence of events (vertically), the source of the operation (field, data processing, or user), the actual operation performed (data preparation, system operation, or data analysis), and the major stop points (horizontal dotted lines). An example of a typical sequence might be as follows: A Title I proposal has been received and is to be evaluated. The proposal data is key punched and checked and an error report is produced. The errors are corrected and the data base tape is prepared. This tape is saved in case other Title I proposals are made for this school district. The model is then operated and a Simulation Output Tape is generated. This tape is also saved to allow in-depth analysis of results at a later time. Analysis of generated data takes place using the Output Tape and reports are produced for the Title I target population. After user analyses of these reports, a request may be made to produce certain in-depth data. In this event, a control card containing the data request will produce further specified reports.

USER INTERACTION DIAGRAM

	Source	Operation
	Field	Filled-out questionnaire and Title I proposal
	Data processing facility	Convert-data to punched cards
ATA OLLECTION	Machine processing	Run editing and cost analysis programs
	User error analysis	Determine corrections needed
ATA ASE. REPARATION	User error correction	Prepare data decks
	User run control preparation	Prepare run deck
	Machine processing	Run data base management system
	Data processing facility	Save data base tape
PERATION	Machine processing	Run simulation Save output tape
NALYSIS	User data analysis	Data Analysis
	User request for additional information	Run analysis system with control card
	User analysis	Further detailed data analysis

Pictorial

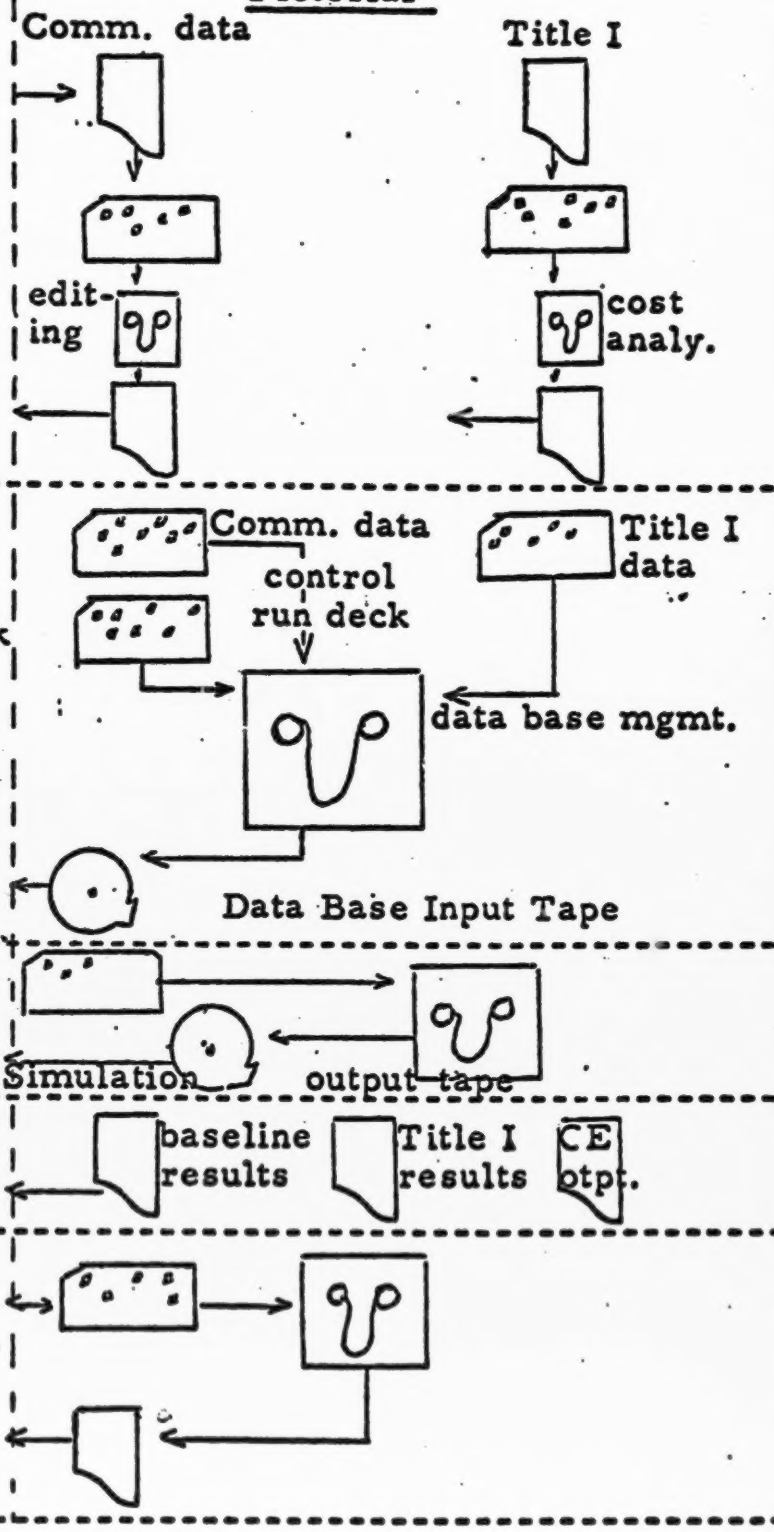

Comm. data
Title I
editing
cost analy.
Comm. data
control run deck
Title I data
data base mgmt.
Data Base Input Tape
Simulation
output tape
baseline results
Title I results
CE otp.

FIGURE II

3. The Data Base Management System

The management system performs three basic functions:

1) Cost Analysis of the Title I proposals;
2) Editing of the keypunched community data;
3) Preparation of the data base input tape.

Figure III illustrates operation of the management system. The Edit and Cost Analysis programs are operated on the punched cards to produce exception reports. This prevents erroneous data being used by the model, and wasted computer runs.

After these decks have been corrected, they are entered on the data base input tape and summary profiles are reported to the user. The profiles summarize the data by target student population, by target curriculum, and by other Title I impacts.

3.1 Cost Analysis

The cost analysis compares pre-stored item costs with proposed expenditures and computes the total program cost for later use in the Analysis Executive Control System.

3.2 Edit

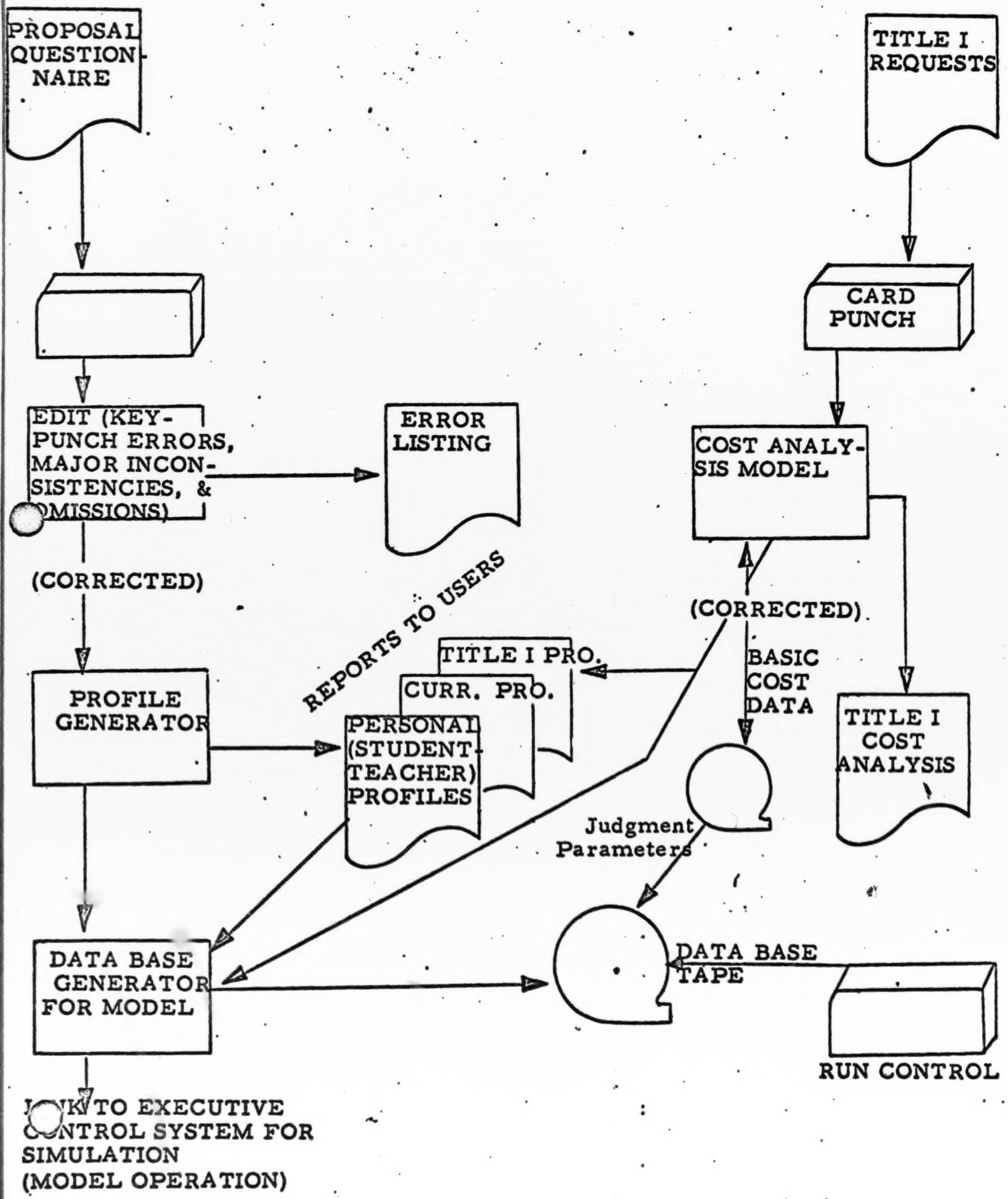
The edit function picks up invalid keypunched characters, omissions, incorrect values, and inconsistent data. An exception report listing each incorrect card is produced to isolate problems.

3.3 Preparation of Data Base

The data base contains two basic kinds of data: empirical data describing the community; and generated data based on statistical distributions, for example, student characteristics. A profile generator creates student, teacher, and curriculum profiles to be used by the model. The data base generator combines these profiles, with the empirical data, and the Title I profile (the effects represented by the Title I request), and with other model coefficients, constants, and costs to create the data base tape. The tape consists of several records. Record I contains the basic cost data to be used by the Analysis Executive. Record II contains the base-line data base, Records III to N each contain the specific Title I profiles associated with the proposal. A control variable (NRUN) indicates the number of Title I profiles to the Executive Control System.

FIGURE III

DATA BASE MANAGEMENT SYSTEM


PROPOSAL QUESTIONNAIRE
TITLE I REQUESTS
CARD PUNCH
EDIT (KEY-PUNCH ERRORS, MAJOR INCONSISTENCIES, & OMISSIONS)
ERROR LISTING
COST ANALYSIS MODEL
(CORRECTED)
REPORTS TO USERS
(CORRECTED)
TITLE I PRO.
CURR. PRO.
BASIC COST DATA
PROFILE GENERATOR
PERSONAL (STUDENT-TEACHER) PROFILES
TITLE I COST ANALYSIS
Judgment Parameters
DATA BASE GENERATOR FOR MODEL
DATA BASE TAPE
RUN CONTROL
LINK TO EXECUTIVE CONTROL SYSTEM FOR SIMULATION (MODEL OPERATION)

4. A Method for Operating the Simulation

There is a need to make each simulation run rapidly and efficiently in order to analyze many communities and many proposals at minimum cost. One way to achieve this is to operate the simulation only over the subset of the total school district directly affected by the Title I proposal. The requirement for data with which to operate the simulation will be directly affected by this operation. Only micro-data specific to the proposal target group need be collected from the school system. For example, a proposed remedial reading program for the elementary school will not require the collection of all Junior and Senior High School statistics. The school superintendent will be required to collect only the data needed to support his proposal.

4.1 Implications for Simulation Operation & Display

Exposing only the target population to the Title I programs implies added constraints on the simulation control system. Parameters must be provided to adjust operation of the simulation chosen target group. The simulation display can be tailored directly to the Title I target group.

Simulation control must be able to expose as small a population group as a single classroom, and as large a population group as the entire school district. Decision rules for aggregating displays for the latter case are needed, to prevent exposing the user to a large amount of data.

4.2 Trade-offs and Costs

Consider two alternative methods of operating the simulation:

1) Focussed simulation runs exposing only the target group,
2) Fixed runs exposing the entire school district.

Focussed Simulation Runs increase the cost of construction, and decrease the cost of data collection to provide increased flexibility of use and short run time. Fixed Simulation Runs decrease the cost of construction, maintain a high fixed cost of data collection, but decrease the flexibility and speed of use. Alternative one affords direct user benefits and is therefore recommended.

5. Executive Control System

The executive control system performs three principal functions: Run control, Model operation, and Simulation result recording. Figure IV represents the Control System operations. Input is from the data base input tape and output is recorded on the Simulation Output tape. The cost-data recorded in Record I of the data base input tape is written as Record I on the output recording tape for later use by the analysis control system. Successive files on the output tape represent sequential run results. The first run is defined as the baseline . There is a run for each Title I proposal. The output tape provides a history of simulated results for each community both with and without Title I programs.

5.1 Run Sequencing

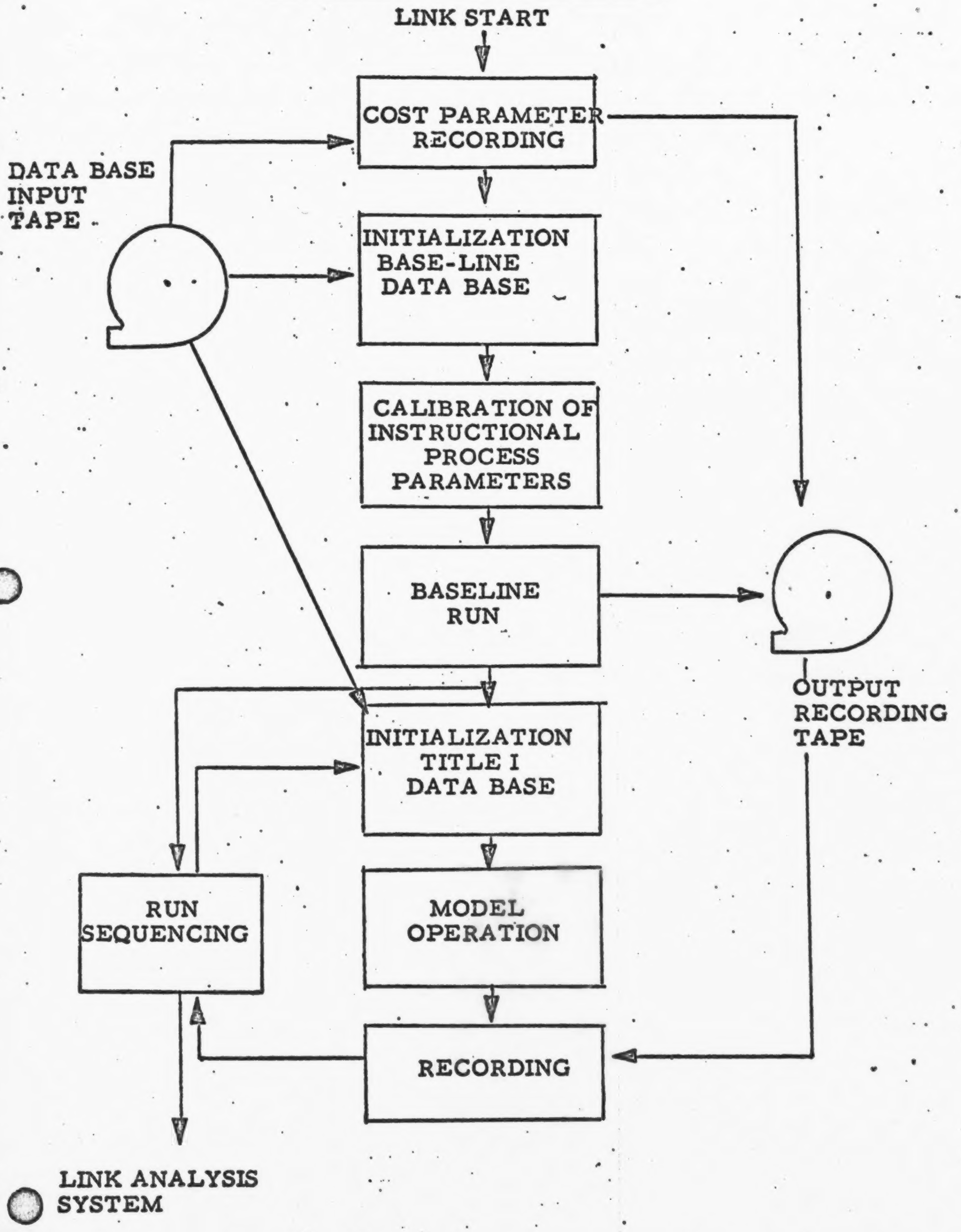
The function of run sequencing is to reset the model data base with the proper settings in order to execute each of the comparative simulation runs. The base-line run is followed by runs incorporating each of the Title I proposals. The data base is restored from the data base input tape. Specific Title I profiles are added and the model is operated.

5.2 Model Operation & Recording

The function of this aspect of executive control is the sequencing of the model subroutines and data base recording. The order of model routines is: Target Group Exposure, Instructional Process, School Network, Community Effects at the end of each sequence the data base is recorded on tape. Separate parameters are used to identify the particular target groups who will be exposed to the Title I programs.

FIGURE IV

EXECUTIVE CONTROL SYSTEM

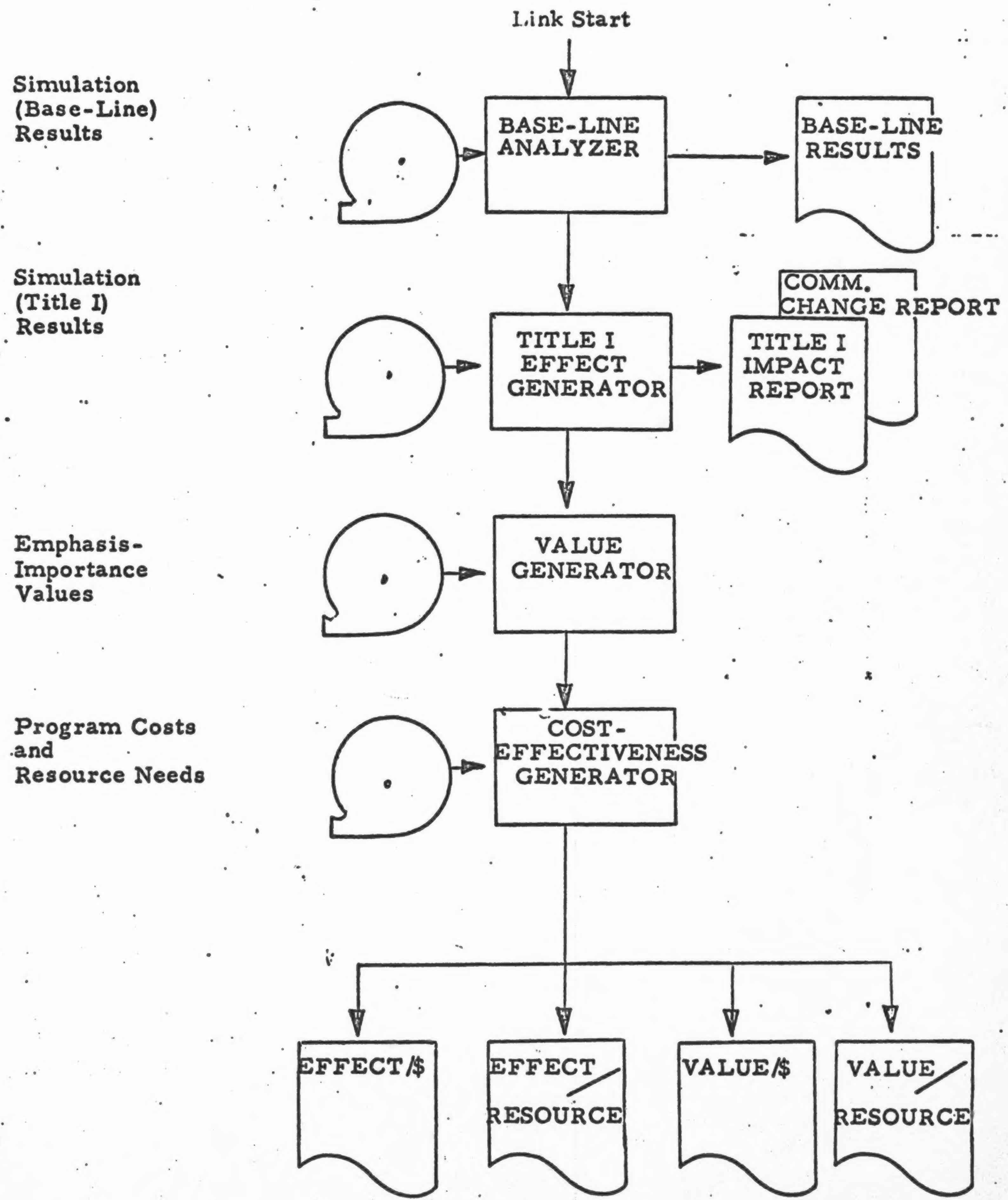

LINK START
COST PARAMETER RECORDING
DATA BASE INPUT TAPE
INITIALIZATION BASE-LINE DATA BASE
CALIBRATION OF INSTRUCTIONAL PROCESS PARAMETERS
BASELINE RUN
OUTPUT RECORDING TAPE
INITIALIZATION TITLE I DATA BASE
RUN SEQUENCING
MODEL OPERATION
RECORDING
LINK ANALYSIS SYSTEM

6. Analysis Executive Control System

The analysis system provides routines to evaluate the simulation results in terms of educational effects, costs, value of the effects, and resources. Comparison of the effects with Title I are compared with the base line to provide an indication of the value of each program proposed. The value of the program is divided by cost to yield an indication of cost-effectiveness. Figure V illustrates the sequence. Input is derived from the Simulation Output tape, and all output is in the form of user reports.

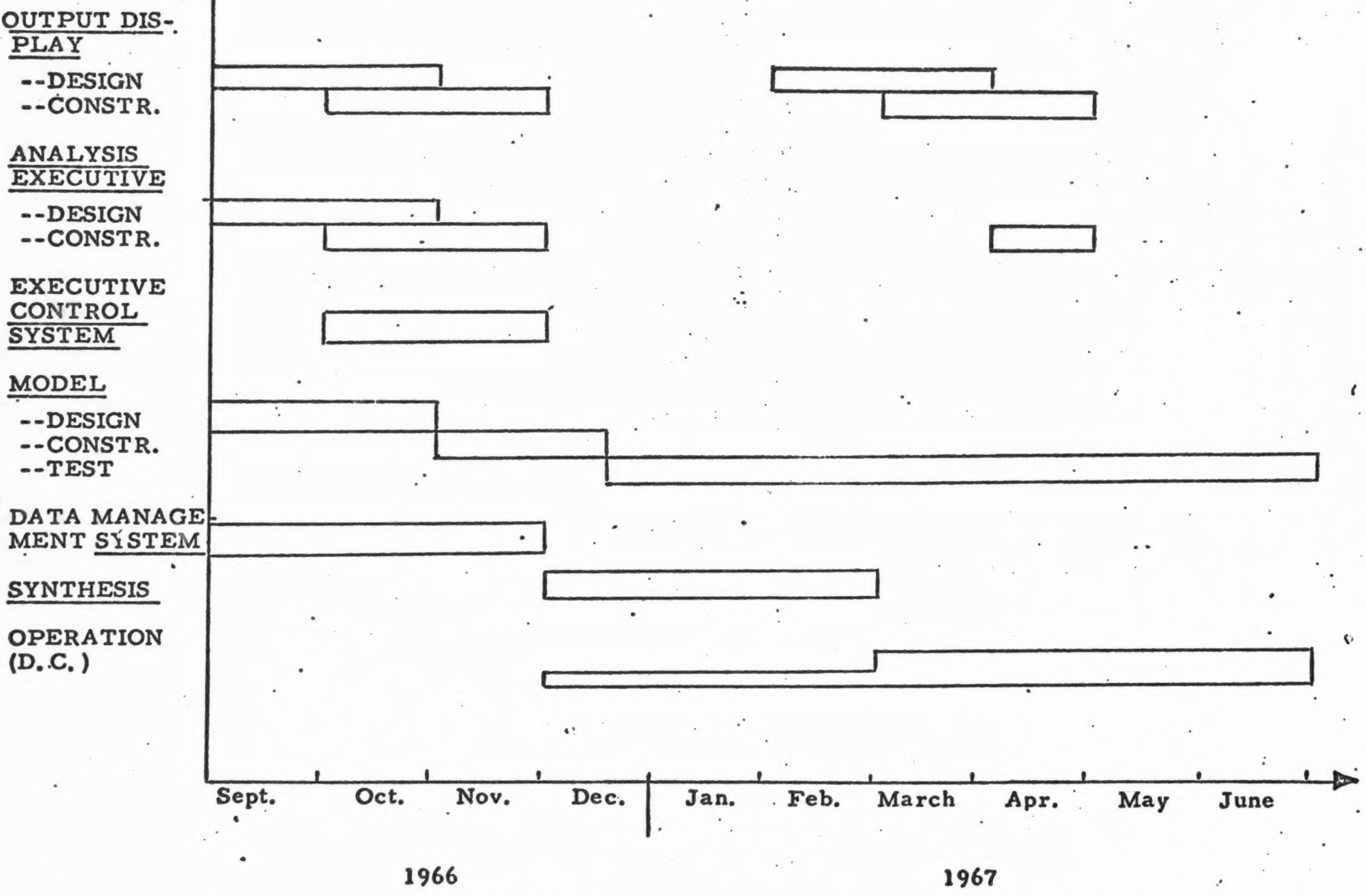
FIGURE V

ANALYSIS EXECUTIVE SYSTEM


Link Start
Simulation (Base-Line) Results
BASE-LINE ANALYZER
BASE-LINE RESULTS
Simulation (Title I) Results
TITLE I EFFECT GENERATOR
TITLE I IMPACT REPORT
COMM. CHANGE REPORT
Emphasis-Importance Values
VALUE GENERATOR
Program Costs and Resource Needs
COST-EFFECTIVENESS GENERATOR
EFFECT/$
EFFECT/RESOURCE
VALUE/$
VALUE/RESOURCE

7. Simulation Planning Schedule

SIMULATION PLANNING SCHEDULE



8. Estimated Computer Operating Time for Education Cost-Effectiveness Model

1. General

The current design is presently estimated to have about a five minute operation cycle for each Title I proposal per community, on the RCA 3301 computer. This excludes data base makeup and analysis of data. The contributions to the five minute cycle are:

Initialization	2.0 min.
Instructional Process	1.0 min
School Network	.5 min
Recording	1.5 min
	5.0 min

2. The School Network

The timing is dependent on two factors: The number of network nodes or cells, and the number of operations/node or cell. The number of nodes is $\approx$ 3 courses of study x 2 income groups x 2 races x 6 achievement categories x n grades affected

or 72n nodes.

We can estimate 100 instructions/node @ 5 μsec/instructor.

Hence: .036n seconds.

	n	Time
Headstart	12	1/2 second
Fourth Grade	8	1/3 second
Secondary School	4	1/6 second

The actual network operation time is not the critical factor. Rather the critical time factors are: calibrating the instructional process, initializing the data base from tape, and recording data on tape.